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Volume 2

Environmental Statement
Crude Oil Transportation Systems

Proposed by: NORTHERN TIER PIPELINE COMPANY
NORTHWEST ENERGY COMPANY
KITIMAT PIPE LINE LTD.
TRANS MOUNTAIN OIL PIPE LINE CORPORATION

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The Crude Oil Transportation Systems Final Environmental Statement is divided into four volumes plus a separate Summary:

Volume 1 contains a description of each of the four TITLE V proposals and a description and analysis of the proposed Northern Tier Pipeline Company system.

Volume 2 contains a description and analysis of systems proposed by Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation. A summary of the four Title V proposals is presented.

Volume 3 contains alternatives to each of the four Systems and public comment on the draft Environmental Statement. Environmental statement team responses are included. Glossary and References.

Volume 4 contains maps relating to each of the four proposals.

Volume 2 contains:

For Northwest Energy Company, Kitimat Pipe Line Ltd., and Trans Mountain Oil Pipe Line Corporation:

Chapter 8 — The Proposals of:
Northwest Energy Company
Kitimat Pipe Line Ltd.
Trans Mountain Oil Pipe Line Corporation
and summary of Title V applicants

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8.1 INTRODUCTION

This chapter addresses the proposals by Northwest Energy Company, Kitimat Pipe Line, Ltd., and Trans Mountain Oil Pipe Line Corporation. The project description for each of these proposals is contained in chapter 1. Executive Order 12114 exempts from environmental analysis as required by the National Environmental Policy Act of 1969 proposals and portions of proposals within foreign countries; therefore, only those portions of the Northwest Energy Company and Trans Mountain Oil Pipe Line Corporation proposals within the United States are discussed. These two proposals are addressed in sections 8.2 and 8.4 respectively, with each section divided into discussions entitled:

Description of the Environment
Environmental Impacts of the Proposal
Mitigating Measures Not Included in the Proposal
Any Adverse Impacts that cannot be Avoided Should the Proposal be Implemented
The Relationship Between Local Short-term Uses of Man's Environment and the Maintenance and Enhancement of Long-term Productivity
Irreversible and Irretrievable Commitment of Resources

It is assumed that the impacts of these two proposals on Canadian resources would be similar to those on United States resources.

Since the Kitimat Pipe Line, Ltd. proposal is located solely within Canada and is exempt from a detailed analysis, its impacts are summarized in section 8.3 within one discussion titled Environmental Analysis.

Section 8.5 summarizes all four proposals submitted under Title V of the Public Utility Regulatory Policies Act of 1978: Northern Tier Pipeline Company, Northwest Energy Company, Kitimat Pipe Line, Ltd., and Trans Mountain Oil Pipe Line Corporation.

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8.2 NORTHWEST ENERGY COMPANY

8.2.1 DESCRIPTION OF THE PROPOSAL

NEC is a corporation whose major subsidiaries include the Northwest Pipeline Corporation, the Northwest Alaskan Pipeline Company (the operating partner of the Alaskan Natural Gas Transportation Company), and the Northwest Exploration Company. The Canadian portion of the portion of the proposed system is sponsored by Foothills Oil Pipe Line Ltd.

NEC proposes a system to transport Alaskan north slope and other crude oil from foreign sources. The crude oil would be delivered to the NEC port facility at Skagway by tanker ships. The proposed pipeline from Skagway to Keg River would be approximately 710 miles, with 14 miles in the United States and 696 miles in Canada. Various existing oil pipelines which originate in Keg River would carry crude oil to Edmonton, Alberta and to most of the northern tier and inland states of the United States.

NEC has stated in its application that pipeline facilities between Keg River and Edmonton would need expansion. NEC also stated that due to the decline in crude oil production there is spare capacity which is increasing year by year.

The present spare capacity is not known, but the proposal shows only a total decrease throughput of 58,800 barrels per day between 1978 and 1982. Also the AGTL 20-inch line from Keg River to Valleyview shows a connection to a 16-inch line, and then at Fox Creek the 16-inch line connects with a 12/20 inch line to Edmonton. The total requirement for expansion in order to provide a reliable pipeline system for NEC throughput between Keg River and Edmonton is unknown. The expansion is not a part of this proposal and would have to be accomplished by others.

In order to provide crude oil to Montana refineries, approximately 70 miles of new pipeline would need to be constructed from Edmonton to Rimbey, Alberta, to tie into the Rangeland pipeline. Finally, a tie-in would need to be made to connect the Portal and Wascana pipelines to deliver crude oil to Mandan, North Dakota.

8.2.2 DESCRIPTION OF ENVIRONMENT

This chapter describes the environment as it exists today, i.e., not including any effects that might result from implementation of the crude oil transportation system proposed by NEC. Environmental components are described to the degree of detail considered necessary for identification and quantification of significant impacts which are anticipated if the proposal is implemented. Environmental factors that would not be significantly affected are not described in detail.

SEA LEG

The sea leg of the NEC proposal encompasses those areas of the high seas and inland waterways that would be traversed by tankers carrying crude oil from widely separated areas. Eighty percent of the crude oil would be shipped from Valdez, Alaska and the other 20 percent would come from other worldwide sources. A description of the existing environment of the high seas associated with the sea leg tanker operation for NEC's proposal has not been included in this environmental statement. The

Skagway, Alaska

Dedman's Photo Shop in Skagway, Alaska

existing environment along Chatham Strait, Lynn Canal, and Taiya Inlet is discussed below.

MARINE RESOURCES

Physical Components

Although the tanker route would pass through inland marine water features identified as straits, canals and inlets, oceanographically these run together into a single continuous feature. The length from the entrance to Chatham Strait at Cape Ommaney to Skagway is 210 nautical miles; the mean width is 6.3 nautical miles. The mean depth is 525 meters; the maximum depth is 840 meters; and the outer sill depth is 330 meters.

Chatham Strait is bounded on the east and west by islands, the largest being Admiralty, Baranof, Chichagof, and Kuiu. The shorelines of these islands are incised by small inlets, which are glacial in origin. Frederick Sound extends east from the southern tip of Admiralty Island; an entrance sill of 310 meters separates the bottom waters of Frederick Sound from those of Chatham Strait. Icy Strait enters Chatham Strait at its northern end; it separates Chichagof Island from the mainland. Icy Strait has a sill at about 50 meters at the entrance to Glacier Bay.

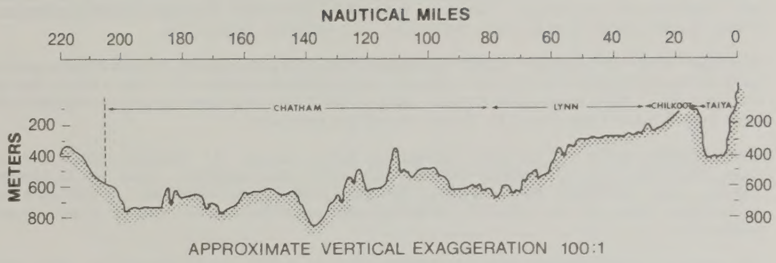
Lynn Canal is bounded on the east and the west by the mainland; it joins Chatham Strait just north of Icy Strait. Stephens Passage, on the east side of Admiralty Island, shoals to about 40 meters near Douglas Island then deepens and joins Lynn Canal through Favorite and Saginaw Channels. Chatham Strait is about 550 meters deep where it merges with Lynn Canal. Hence, because of sills in Stephens Passage, Icy Strait, and Frederick Sound, the bottom water characteristics of Lynn Canal are essentially the same as, and are controlled by, the bottom water characteristics of Chatham Strait.

Lynn Canal is the northernmost inlet of the inland waterways of southeast Alaska. The shoreline of Lynn Canal is steep and rugged. Numerous streams and rivers enter the surface water, forming a surface layer of brackish water, which flows seaward under its own hydraulic gradient.

The bottom waters of Taiya Inlet are separated from the bottom waters of Lynn Canal by an entrance sill that is 77 meters deep. Taiya Inlet itself is over 400 meters deep.

Sediment from the Chilkat River has built up a large delta at the head of Chilkat Inlet. Sediment from the Katzehin River has built up a large delta which extends nearly halfway across the Chilkoot Inlet. The delta of the Katzehin River poses a significant hazard to navigation for vessels calling on Skagway, presenting the narrowest channel width of the transit.

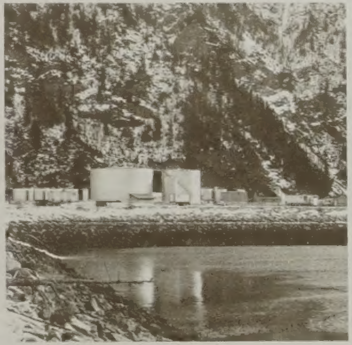
The glacial origin of the inland waterways of southeast Alaska has produced a very rugged, steep-sided terrain which continues below the water. In cross-section, the inland bodies of water are essentially U-shaped and reach great depths very close to the shore. Figure 8.2.2-1 presents a longitudinal section of Chatham Strait-Lynn Canal-Chilkoot Inlet-Taiya Inlet.



LONGITUDINAL SECTION ALONG CHATHAM STRAIT, LYNN CANAL, CHILKOOT INLET AND TAIYA INLET

(ADAPTED FROM PICKARD, 1967)
NOTE THE SILL AT THE ENTRANCE TO TAIYA INLET, WHICH EFFECTIVELY ISOLATES THE BOTTOMWATER OF TAIYA INLET FROM THE BOTTOMWATER OF LYNN CANAL

Figure 8.2.2-1


Tanks near commercial dock in Skagway

Carcross Road
Skagway, Alaska

Bureau of Land Management

The shoreline inventory was based on an analysis of aerial photographs and U.S. Geological Survey topographic maps. Of the amount of shoreline inventoried, approximately 1,500 miles are rocky, 500 miles are cobbles, pebbles, or gravel, 400 miles are unprotected beaches of sand to mud, and 300 miles are protected intertidal areas of fine sand to silt with intertidal and emergent vegetation.

The east shore of Baranof Island is indented with small glacial fjords; the exposed east shore is mostly rock, with numerous small pocket beaches. It is a high energy environment. The steep-sided fjords have mostly rocky shores or coarse beaches and have very little fine material in the shoreline sediments.

The northern shore of Baranof, bordering Peril Strait, is indented with several moderate-sized inlets, notably Rodman Bay while the southern shore of Chichagof Island, also bordering Peril Strait, is fairly straight. Because of the lack of protection, most of the southern shore of Chichagof Island is rock or coarse beach material.

The eastern side of Chichagof Island consists of mostly rocky shoreline, with some coarse beach material in places. Tenakee Inlet and Freshwater Bay are two large inlets on the east side of Chichagof, the former extending more than 35 miles to the west. The southern shore of Tenakee Inlet has numerous rocky-shored inlets with fine materials and emergent vegetation at their heads. The northern shores of Tenakee Inlet are mostly rocky, with coarse beach material in some places and fine beach material in others. Like the northern shore of Peril Strait, the northern shore of Tenakee Inlet is fairly straight, with no protected inlets.

The shores of Freshwater Bay are mostly of rocky or coarse material. Some fine beach material occurs in places and emergent vegetation is evident at the head of Freshwater Bay.

The northern shore of Chichagof Island is mostly composed of coarse beach material. Port Frederick, a large fjord, extends about 15 miles inland from the northern shore, almost merging with the head of Tenakee Inlet. The shores of Port Frederick include rocky, coarse beach, fine beach, and fine beach material with emergent vegetation.

Pleasant Island, located in Icy Strait, about 25 nautical miles from Chatham Strait, is mostly coarse beach material with a small stretch of rocky shore at the eastern end. The northern shore of Icy Strait is mostly coarse beach material and rocky shore, including the more protected shore of Excursion Inlet.

The open coast shoreline of western and northern Kuiu Island is rocky. Fine beach materials occur at the heads of the inlets and bays of Kuiu Island; emergent vegetation is present. The shores of nearby small islands are mostly rocky. Some coarse beach material is present on the southern shore of the Bay of Pillars and on the northern shore of Saginaw Bay.

The shoreline of the western side of Admiralty Island is almost totally rocky. Large inlets occur on the southern half of Admiralty Island, while the northern half is mostly straight, rocky shore. Large inlets on Admiralty Island include Gambier Bay, Pybus Bay, Eliza Harbor, Whitewater Bay, Chaik Bay, Hood Bay, and Kootznahoo Inlet. Fine beach material with emergent vegetation exists at the heads of most of these inlets; the majority of their shoreline remains rocky. Some coarse and fine beach material does occur along the sides of these inlets but is not common.

The northern half of Admiralty Island bordering Chatham Strait is incised by Hawk Inlet. Most of the shoreline of Hawk Inlet is rocky, although some fine beach material is found at the head of it and also in several small pockets at the southern end of the inlet.

Lynn Canal has fewer inlets than Chatham Strait. Many streams and rivers entering Lynn Canal and its northern inlets carry a tremendous amount of sediment and large deltas are present. Three of these are at the northern end of Berners Bay; at the head of Chilkat Inlet; and on the eastern side of Chilkoot Inlet, the Katzehin River. Other deltas are present from the Eagle and Herbert Rivers (on the southeastern shore of Lynn Canal), the Endicott River (on the central western shore of Lynn Canal), and several other glacier-fed rivers on the northwestern shore of Lynn Canal.

Aside from the deltas, which consist of a mixture of fine to coarse beach materials, most of the shoreline of Lynn Canal is rocky. Some coarse material beaches are found in places, with most bordering Chilkat Inlet and the western shore of Chilkoot Inlet in the vicinity of Haines.

To the south, Lynn Canal also joins Stephens Passage. Most of the shoreline of the eastern part of Admiralty Island and the western part of Douglas Island adjacent to Stephens Passage consists of rock or coarse beach material. Fine beach material is present in Young Bay, and a vast expanse of fine beach material with emergent vegetation is present between Douglas Island and the mainland northwest of Juneau.

Lynn Canal has several relatively large islands at the northern and southern ends. Their shorelines are rocky with some coarse beach material. Fine beach material with emergent vegetation is also present at the northern end of Saint James Bay on the western side of Lynn Canal.

The shoreline of Taiya Inlet is almost exclusively rocky. Delta deposits are present where the Taiya and the Skagway Rivers enter the northern end.

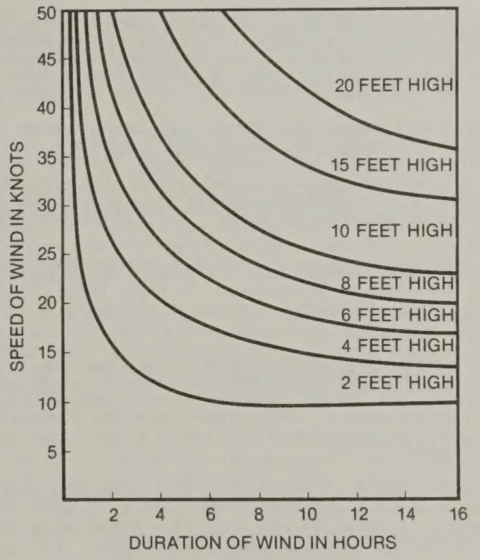
Fine sediments exist on the shoreline primarily in the sheltered inlets that branch off from Chatham Strait and Lynn Canal.

Glacier-fed streams and rivers with very high bed and suspended sediment loads have built deltas along the shoreline because their rate of sediment supply has exceeded the rate of which the waves and currents could carry it away.

Little information exists concerning the waves in the area. Hydrographic data sheets from oceanographic cruises provide occasional rough observations of waves, but this information is of limited use. Hydrographic measurements for December or January are non-existent.

Wind data, necessary to estimate frequencies of various wave parameters in the absence of actual wave data, are also inadequate. McLain (1969) noted that average wind speeds for Eldred Rock (northern Lynn Canal) ranged from 12 knots in the summer to over 20 knots in the winter; for Point Retreat (southern Lynn Canal) wind speeds ranged from 6 knots in the summer to 15 knots in the winter. The winter winds are generally from the north while the summer winds are from the south.

Figure 8.2.2-2 presents the relationship between wind speed, wind duration, and the resultant significant wave heights. Individual waves may exceed significant wave heights. Figure 8.2.2-2 assumes an unlimited straight distance over which the wind



RELATIONSHIP BETWEEN WAVE HEIGHTS, WIND SPEED AND DURATION FOR UNLIMITED FETCH

(FROM BASCOM 1964)

Figure 8.2.2-2

blows (fetch). Because of channel configuration, this does not exist in the area. However, fetches of 120 nautical miles are available in Chatham Strait, 50 nautical miles in Lynn Canal, and 15 nautical miles in Taiya Inlet. Significant wave heights to wind speed and fetch are related in table 8.2.2-1.

Winds often exceed 20 knots, and maximum significant wave heights (from table 8.2.2-1) for 30 to 40 knots and fetches of 10, 50 and 100 nautical miles are likely in Taiya Inlet, Lynn Canal, and Chatham Strait, respectively.

TABLE 8.2.2-1 HEIGHTS OF WAVES, IN FEET,
THEORETICALLY PRODUCED BY WINDS OF VARIOUS STRENGTHS
BLOWING OVER DIFFERENT FETCHES

Wind Velocity in nautical miles per hour	Fetch in nautical miles 10	50	100	300	500	1000
10	1.5	2.0	2.0	2.0	2.0	2.0
15	3.0	4.0	4.5	5.0	5.0	5.5
20	4.0	6.5	8.0	9.0	9.0	9.5
30	6.0	12.5	15.0	18.0	19.0	19.5
40	7.0	17.5	23.0	30.0	32.0	35.0
50	9.0	22.0	30.0	43.0	47.0	52.0

Source: NEC 1979

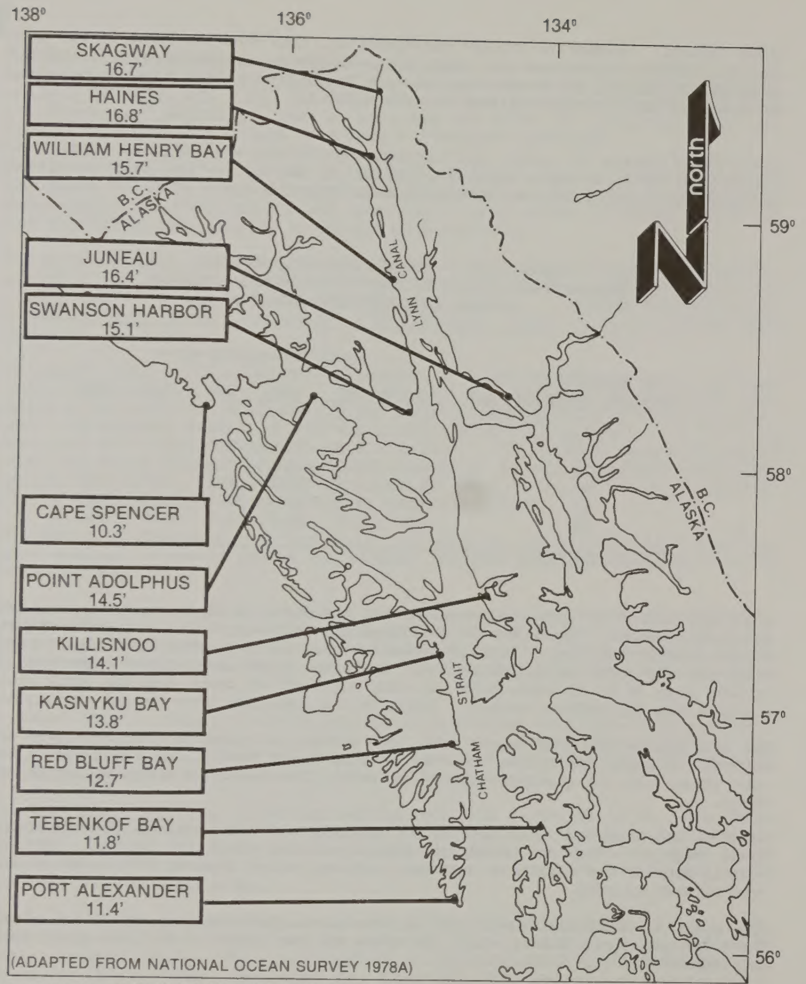
Winds may exceed 40 knots on occasion, but the duration of these winds may limit the wave buildup. The winds in the Taiya and Chilkoot Inlets are quite strong. Northerly winds may rise to over 100 miles per hour and very often reach the 50 to 60 miles per hour range in Chilkoot Inlet. The winds in Taiya Inlet have been known to reverse from 30 to 35 knots from the south to 40 to 45 knots from the north while a vessel was approaching Skagway. Winds in the area also show diurnal variations.

The wave regime that can result under such severe and variable wind conditions and channel configurations is complex. Gentle long period swells, characteristic of the open ocean, are not given the chance to form. The waves are short in length and steep.

Waves of the sizes described here do not severely restrict movements of large ocean-going vessels. They do affect complicated docking maneuvers, however. Smaller vessels such as tug escorts or tugboats with barges are severely restricted by this type of wave activity.

The tides in southeast Alaska are of the mixed, predominantly semidiurnal type. There are two approximately equal low tides and two unequal high tides every tidal day (approximately 24.8 hours).

The tide may be thought of as a wave, with low tide being the trough and high tide being the crest. The tide wave enters Chatham Strait via its southern entrance, and



(ADAPTED FROM NATIONAL OCEAN SURVEY 1978A)

Figure 8.2.2-3 **DIURNAL TIDE RANGES FOR SELECTED LOCATIONS (MEAN HIGHER HIGH TO MEAN LOWER LOW WATER)**

via Icy Strait to the north. The lower Chatham Strait portion splits into two portions, one traveling up Frederick Sound to the east. The Icy Strait wave splits as it enters Chatham Strait, with the northern portion extending into Lynn Canal and its inlets. The time of corresponding high and low tides throughout Lynn Canal differs by about 20 minutes, so the tide behaves more as a standing wave than as a progressive wave.

The tide range increases as it travels into the long inlets of southeast Alaska. Mean diurnal ranges (mean lower low water to mean higher high water) increase from 11.4 feet at Cape Ommaney to 16.7 feet at Skagway. Tidal information is presented for Chatham Strait, Icy Strait, Lynn Canal, and Chilkoot and Taiya Inlets in figure 8.2.2-3.

Actual current data for the study area are sparse, particularly surface current data that can be related to local wind data. The National Ocean Survey (U.S. DOC 1978b) publishes current predictions annually and includes stations within Chatham Strait, Lynn Canal, Chilkoot, and Taiya Inlets. McLain (1969) conducted drogue studies in southern Lynn Canal and summarized results of previous drift card studies by others.

Surface currents are driven by tidal forces, wind drift, and the addition of freshwater to the area from runoff and precipitation. Their net direction is generally seaward. Tidal currents are oscillatory, whereas the wind drift and freshwater induced estuarine flow will be a relatively steady one superimposed on the tidal currents, resulting in a net surface transport in one direction and a compensatory flow in the opposite direction at depth. The surface flow occurs generally in the upper 30 meters.

The Coriolis effect is an apparent force that produces a deflection to the right of a moving body in the northern hemisphere. Coriolis force significantly affects currents in the area, with currents strongest on the right in the direction of motion.

Figure 8.2.2-4 presents the average maximum tidal currents in the area according to the current predictions of the National Ocean Surveys (U.S. DOC 1978b). Wind drift and estuarine flow are not intended to be represented in the tidal current predictions. Possibly some of these effects were not completely removed by the National Ocean Survey as the ebb flow (0.7 knots) in Lynn Canal is roughly twice the flood flow (0.3 knots).

Wind drift currents, when fully established, will equal about 3 percent of the wind speed, and normally would be deflected to the right by Coriolis force. However, the basin configuration will cause the wind drift to be channeled in the direction of the channel, with the flow being strongest on the right side.

Aerial photograph analysis of river plumes in Taiya and Chilkoot Inlets and Lynn Canal has provided some general indications of surface flow. The river plumes are especially visible in summertime due to high suspended sediment load. On a flood tide traces of the Taiya and Skagway River plumes are evident as far south as the entrance to Taiya Inlet (15 nautical miles), and a large eddy formation the width of the channel may be present. The flood current is strongest in the center of the channel and the plume is concentrated along both sides of the inlet, resisting the northerly flood tide current. The plume of the Katzehin River is evident south of Seduction Point (about 10 nautical miles from its source) on an ebb current and extends completely across the southern half of Chilkoot Inlet.

McLain (1969) noted that surface flood currents hugged the eastern shore and surface ebb currents hugged the western shore of southern Lynn Canal. Transverse or lateral currents in Lynn Canal were also observed.

Tidal currents in Chatham Strait are more complex than in Lynn Canal. Chatham Strait is open to the Pacific Ocean via Icy Strait at its north end, and is directly open to the Pacific at its southern end. Numerous large inlets, including Tenakee Inlet, Peril Strait, and Frederick Sound, affect tidal circulation patterns within Chatham Strait. The currents within the inlets are highly complex. Figure 8.2.2-4 illustrates the different directions for ebb and flood currents in northern and southern Chatham Strait. The entrance to Kootznakoo Inlet on Admiralty Island is restricted and tidal currents there exceed 7 knots.

Salinity layering is pronounced during the summer months, particularly in Taiya Inlet. The brackish water is a layer with 32 parts per thousand salinity found below 50 meters in the majority of samples analyzed. Salinity of 32 parts per thousand is always found below 100 meters along the entire stretch of water from the southern tip of Baranof Island to Skagway.

Freshwater inflow in the winter months is much less and nearly non-existent in the northern portion due to fluctuating freezing of the rivers.

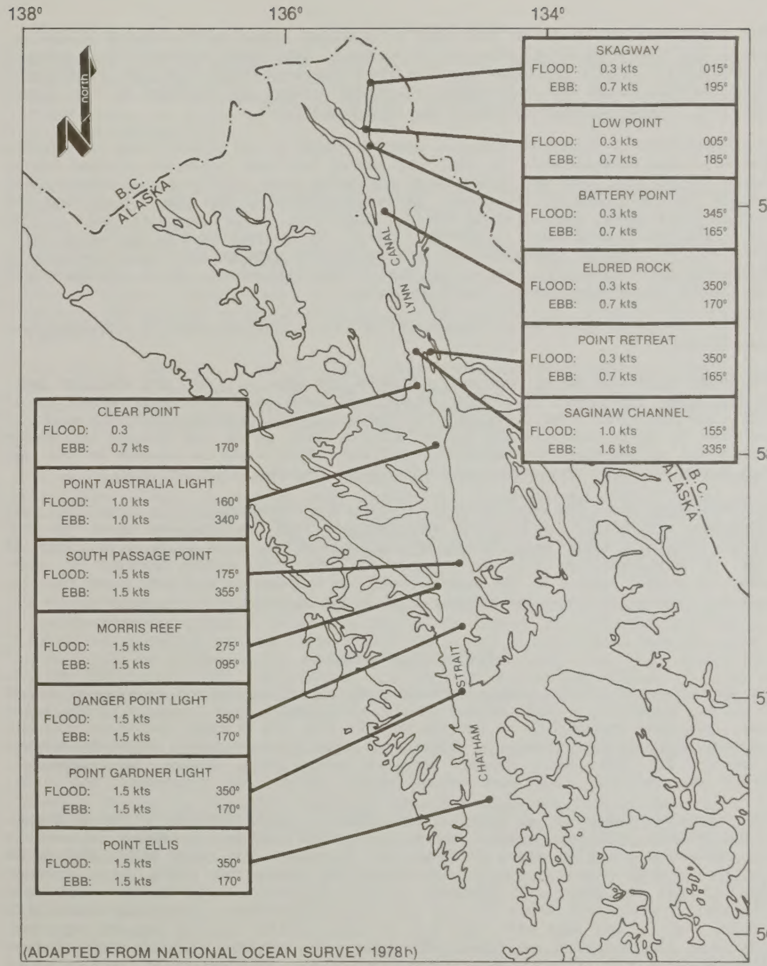
Water temperature maximums of 13°C in summer are noted in all areas. Temperatures during the winter months are fairly uniform from surface to depth and show a gradual decrease from between 5 to 6°C (at the entrance to Chatham Strait) to 3 to 4°C (in the mid-upper portion of Chatham Strait). In Lynn Canal 2 to 3°C temperatures result from ice formation. Temperatures less than 3°C are noted in Taiya Inlet below 150 meters throughout the year.

Oxygen levels from 6 to 9 milliliters per liter (ml/l) are observed at the surface in all areas with the greatest concentrations occurring during the summer months coinciding with photosynthesis. The lowest values are noted in October and November from surface to depth (below 200 meters), decreasing to less than 3 ml/l in the main portion of Chatham Strait. The exception is Taiya Inlet, where oxygen levels at 300 meters are 5 ml/l or more.

The sill at the entrance to Taiya Inlet is the only obstacle along the entire channel to obstruct or hinder the inflow of deep Pacific water. Water with low oxygen levels (2.5 to 3.4 ml/l) at depth at the southern entrance of the Strait is moved to the sill at Taiya Inlet as a continuing process.

At Taiya Inlet, it can be seen that the oxygen levels between October and March are in the same low profile. These low levels of oxygen at depth (200 meters or more) are the result of convective transfer. During the summer months there is an upwelling all along the outer Pacific Coast over the shelf. This is not strong enough, however, to bring water from 500-meter depth to the surface. As a result there is oxygen-minimum water on the shelf which moves up the Chatham Strait-Lynn Canal fjord to the sill at Taiya Inlet. By comparison, it is lower in oxygen than the entrained waters of Taiya Inlet. Oxygen levels of 5 ml/l and greater are retained in the Inlet during the summer months down to a depth of 100 meters and are mixed uniformly in the water column.

There is a small wastewater input into these waters from municipal sewage and the forest products industry (Alaska Department of Environmental Conservation 1978).



(ADAPTED FROM NATIONAL OCEAN SURVEY 1978h)

Figure 8.2.2-4. AVERAGE MAXIMUM FLOOD AND EBB CURRENTS FOR SELECTED LOCATIONS

This wastewater is likely to have only a localized effect on the marine resources, due to the nature of circulation in the channel. Municipal wastewater from Skagway is subject to secondary treatment before discharge into Taiya Inlet but infiltration of groundwater into the old wooden collectors causes an overload of the system resulting in the discharge of raw sewage into Taiya Inlet.

No measurements of suspended sediment concentrations in the channel have been found. However, water transparency in June and August has been measured (Pickard 1967). Values ranged from less than 3 meters at the Taiya Inlet sill to 6 or 7 meters along most of the lower part of Lynn Canal. Values decreased to less than 1 meter near the head of Taiya Inlet, where most of the silt-laden river water enters the Inlet. This relatively low transparency is probably due to the seasonally high inflow of silt-laden runoff. Higher transparencies are associated with greater salinities as the freshwater mixes with the seawater and more of the silt sinks. Water transparencies are greater in the winter when runoff is less.

No measurements of trace metal concentrations in the channel water or sediments have been found.

The total concentration of inorganic nitrogen (nitrate, nitrite, and ammonium ions) in the upper 100 meters of Chatham Strait and Lynn Canal may range from 1 to 10 microgram-atoms per liter in November. Inorganic nitrogen concentrations would be expected to be depleted in the photic zone by late spring and through the summer months due to increased phytoplankton activity. They would be renewed in the fall from mixing with the deep water due to increased wind and storm activity.

Only one measurement has been found for hydrocarbon concentrations in Lynn Canal, 0.1 micrograms per liter. This value was averaged from four samples taken from the surface water of Lynn Canal (Clark and MacLeod 1977). This value is at least an order of magnitude less than the other total hydrocarbon values reported for other areas of Alaskan waters in the same source. No information has been found relating to the background hydrocarbon concentration in the sediments of the channel.

Biological Components

The marine waters of the proposed tanker route from Cape Ommaney to Skagway abound in marine resources. Other marine waters and coastal areas, especially the outer coast, are also susceptible to adverse impacts from the proposal and where possible critical or sensitive habitats in these other areas are discussed. Abundant in these areas are fin fish (e.g., salmon, herring), crabs (king, Tanner, and Dungeness), marine mammals (sea lions, sea otters, seals, whales, and porpoises), and birds.

The shoreline along the proposed tanker route is predominantly rocky with some coarse beaches (cobbles, pebbles, or gravel), some unprotected beaches of sand to mud, and some protected areas of fine sand to silt. The rocky areas tend to be very productive, contain diverse assemblages of fauna and flora, have abundant algae growth, and have some important subtidal fishes. Coarse beaches range from relatively unproductive areas to rich and diverse stretches. Protected areas, with cobble, gravel, and sand with high mud and silt content usually support important clam beds, subtidal fish, eelgrass, and algae. The unprotected beach areas of fine sand are relatively unproductive, are exposed to high to moderate action from waves and currents, and have low diversity and very little algae present. The protected areas of fine sand to silt are productive and diverse, contain important oyster beds and often eelgrass, support clam production, are utilized by crabs and subtidal fish, and are important shore bird feeding areas. Protected areas would be the most sensitive to oil pollution, due in part to the rather long recovery periods (rocky areas--1 to 2 years; protected areas--5 to 10 years). The locations of the protected areas include Port Frederick (Chichagof Island), St. James Bay, Berners Bay, inlets off Stephens Passage, Chilkat Inlet, mouth of the Ketzchin River, and near the mouth of Taiya River.

The inland marine waters of southeastern Alaska support substantial commercial, sport, and subsistence fisheries. Commercial fishing is discussed in the section on Sea Leg Economic Conditions.

All the passages of the inland waterway serve as migratory routes for salmon, which are harvested in other areas. Salmon also serve as food for many larger fishes and marine mammals, and during spawning are essential food to large numbers of terrestrial mammals and birds.

Specific habitats are important to the maintenance of fisheries in the area of Icy Strait, Chatham Strait, and Lynn Canal. These include migration routes, spawning areas, juvenile rearing areas, and feeding areas. Many of these areas have not yet been delineated for southeastern Alaska waters. What is known are the major harvest areas and spawning areas for anadromous fish. (See Map Addendum.)

Unlike most other commercial fisheries, the major herring fishing areas are also major spawning areas for herring. Little is known concerning locations of rearing areas and nurseries for fish and shellfish. Large concentrations of young crabs have been observed in Echo Cave (south shore of Berners Bay, Lynn Canal) and St. James Bay (west shore of Lynn Canal) (see Map Addendum). Other areas have not been identified.

Herring, pink and chum salmon, and some shellfish spawn in the highly productive intertidal zone. Aquatic plants provide abundant food and shelter for the rearing of young fish.

A number of fish hatcheries are located in southeastern Alaska. Hatcheries include Auke Bay (joint federal/state) northwest of Juneau, Kowee Creek (privately owned) on Douglas Island, Snettisham hatchery (state) at the head of Port Snettisham, Hidden Falls (state) and Little Port Walter (federal) in Chatham Strait, and Starrigavin (state) and Sheldon Jackson (operated by the college) near Sitka. Hatcheries represent major monetary investments and provide critical support for maintenance and enhancement of southeastern Alaska's fishery resources.

Substantial sport fishing occurs in the Sitka, Juneau, Haines/Skagway and Glacier Bay areas. Table 8.2.2-2 lists the "days fished" and the number of each species caught.

Subsistence fishing activities occur near all small villages bordering Icy Strait and Lynn Canal. The principal species harvested include salmon, Dolly Varden, herring, halibut, smelt, king, Tanner, and Dungeness crab, and several species of clams. No estimates are available concerning the monetary value of subsistence fishing.

Prevalent in the marine waters of southeastern Alaska are many species of marine mammals including the endangered humpback and Pacific gray whales.

Sea lions, sea otters, and harbor seals frequent the area. Infrequent visitors or strays sighted in the area are fur seals and elephant seals. Sea lions frequently

TABLE 8.2.2-2 SPORT FISHERY DATA, 1977

	Days Fished	King	Coho	Red	Pink	Chum	Halibut	Steelhead	Cutthroat Trout	Dolly Varden	Rockfish	Other
Juneau Area 1/												
Boat	63,708	5,550	17,377	1,349	4,405	147	1,782	25	119	2,170	2,634	1,465
Shoreline	17,595	827	2,355	973	1,389	118	194	8	187	3,799	362	419
Total	81,303	6,377	19,732	2,322	5,794	265	1,976	33	396	5,969	2,996	1,884
Haines/ Skagway 2/												
Boat	4,211	462	130	0	258	7	70	0	59	546	116	108
Shoreline	1,383	9	1,118	123	251	48	11	0	3	348	14	797
Total	5,594	471	1,248	123	509	55	81	0	62	894	130	905
Glacier Bay 3/												
Boat	2,614	356	644	231	71	0	256	0	0	28	34	6
Shoreline	399	0	100	0	51	0	15	0	12	274	0	0
Total	3,013	356	744	231	122	0	271	0	12	302	34	6
Sitka Area 4/												
Boat	24,178	1,716	2,531	377	6,556	139	976	23	178	1,245	3,567	2,198
Shoreline	6,639	22	324	243	2,823	2	16	20	48	1,330	68	1,143
Total	30,817	1,738	2,855	620	8,389	141	992	43	226	2,575	3,635	3,341

Source: ADF&G 1979

1/ Juneau Area: All waters from Cape Fanshaw to Point Sherman, including Berners Bay and all of Admiralty Island.

2/ Haines/Skagway Area: All waters from Point Sherman to the Canadian Border.

3/ Glacier Bay Area: All waters from Cape Fairweather to Icy Strait and eastward to Point Couverden.

4/ Sitka Area: Baranof and Chicagof Islands and associated waters.

5/ Not included for Sitka area are 10,309 razor clams and 44,931 smelt.

follow and feed on herring and other fish as they spawn. Sea lions are basically migratory, moving from the outer exposed coast into the inland passages during winter. See the Map Addendum for location of haul-out areas and breeding rookeries. These areas are based on limited data, and thus the population of sea lions is probably underestimated.

Sea lion haul-out areas are found throughout the district. The four major areas are Hazy Islands at the southern entrance to Chatham Strait (2,500 sea lions), Biali and Jacob Rocks south of Sitka (650 sea lions), White Sisters on the west coast of Chichagof Island (700 sea lions), and Benjamin Island in Lynn Canal (400 sea lions). Surge Bay area on the southern, seaward side of Icy Strait is the most critical area for sea otter; surveys indicate over 50 percent of the southeastern Alaska population resides there. Because they are a reintroduced species, the current pattern in habitat use may not be an accurate measure of the habitat necessary for successful repopulation.

Sea otters, abundant prior to 1800, were exterminated during the 19th century. The present population is the result of transplants made during 1965-1969 and the populations seem to be sustaining a healthy growth rate. Surge Bay contains over 50 percent of the southeastern Alaska sea otter population.

Survey data on harbor seals are fragmented and no complete population counts are available. Areas which have been successfully surveyed and contain dense populations, at least seasonally, are shown in the Map Addendum. Concentrations of harbor seals are found feeding on migratory fish near the heads of bays and in areas where disturbance is minimal, which may indicate a sensitivity to human activities.

Numerous whales and porpoises inhabit the waters of southeastern Alaska. Whale species commonly found in nearshore and inside waters are humpback, Pacific gray, and Minke; porpoises include killer whale, Dall, and harbor. Whale species which may occur at least seasonally in offshore waters include blue, fin, sei, sperm, right, giant bottlenosed, and goose-beaked; the Pacific white-sided dolphin is also present. Of these offshore species only the fin whale regularly occurs nearshore; they rarely occur in inland waters.

Humpback whales migrate into the area in March or April and leave during the fall for overwintering areas in the central Pacific.

Stevens Passage is a highly important area for humpbacks, and as much as 60 percent of the total population in southeastern Alaska may utilize this area. Other important areas are Icy Strait, Chatham Strait, Sitka Sound, Auke Bay, lower Lynn Canal, and the outer coast (see Map Addendum). The use of Lynn Canal is low relative to the amount of habitat available; this may be a result of human activity. Humpbacks appear to be sensitive to noise generated by large vessel traffic, and to intense commercial fishing activity.

During the seasonal migration from Mexico to the Bering Sea, the eastern Pacific gray whale passes along the outer coast of southeast Alaska. Most gray whales follow the shoreline closely as they move north in the spring migration. It is possible that a very few individuals may spend the summer along the outer coast of southeast Alaska (ADF&G, 1979).

Minke whales are also present in the southeastern Alaska area. Usually solitary, these whales occassionally concentrate in areas of local food abundance. The eastern end of Icy Strait and Glacier Bay are areas where they have been frequently sighted.

Killer whales, the largest member of the dolphin family, are frequently sighted in lower Lynn Canal and Frederick Sound. Pods of killer whales are sometimes associated with concentrations of seals and sea lions. Killer whales, apparently transient in the region, are also commonly observed in Icy Strait, Chatham Strait, Stephens Passage, near Sitka, and in upper Lynn Canal at the entrance to Chilkat Inlet.

About 60 species of marine birds, shore birds, waterfowl and terrestrial birds use the inside marine environment and an additional 50 species are presently considered uncommon or rare visitors. No detailed study of bird populations in the area of Icy Strait, Chatham Strait, and Lynn Canal has been conducted. Thus the estimates of the number of species and the size of bird populations are probably low. This area is an extremely rich source of marine foods, has relatively large tidal ranges, and probably provides a valuable habitat for birds that nest in the less productive habitats just to the north.

Gulls, terns, alcids, and cormorants are the dominant groups of marine birds present in the area. (See Map Addendum for location.) Gulls, estimated to number into the hundreds of thousands, use the intertidal region, sheltered areas, and open waters. Dominant in the winter are glaucous-winged and herring gulls. Thayer's, mew, and Bonaparte's gulls are abundant during migration. The Arctic tern, a common nester and migrant in the area, is estimated to be present in some tens of thousands. The alcids, pigeon guillemot, and marbled murrelet, are also common nesters. The guillemot is present in thousands and murrelet in tens of thousands. Thousands of common murres are present in spring and fall. The pelagic cormorant is common in fall, winter, and spring, numbering in the hundreds.

Loons, grebes, and herons are not entirely marine but live a major part of their life in marine waters. The common loon and the red-throated loon are year-round residents with populations in the thousands. The Arctic loon, populations estimated to be in the thousands, is a migrant in the spring and fall. The yellow-billed loon is the largest and rarest of the loons and is regularly seen in this area. The red-necked and horned grebe are both common in migration. Great-blue herons occupy the area year-round.

Shorebirds occur all along the intertidal zone with major concentrations on the outwash plains of Gustavus, Eagle River, St. James Bay, Berners Bay, and Chilkat River. During migration the total population of shorebirds may reach hundreds of thousands.

Nesting species are black oystercatchers, semipalmated plover, killdeer, greater and lesser yellowlegs, and spotted sandpiper. Wintering species include black oystercatcher, black turnstone, rock sandpiper, dunlin and northern phalarope. Common migrants in the spring and fall include semipalmated plover, pectoral sandpiper, least sandpiper, short-billed dowitcher, and western sandpiper. Many of these species migrate great distances and this region is an important feeding area for them.

TERRESTRIAL VEGETATION

Dense forests dominated by western hemlock and Sitka spruce are found above the high tide line along the tanker route from the south end of Chatham Strait to Skagway. The composition of these forests varies somewhat, and the percent composition of hemlock increases northward. Western hemlock makes up 60 to 80 percent of the forests while Sitka spruce makes up most of the remaining. Western red cedar and Alaska cedar are also found in the forested areas but decrease in abundance toward the north end of the Strait (Harris et al. 1974). The best developed forests grow just above high tide line with height of trees, timber volume, and quality decreasing progressively upslope.

Subalpine fir is found in drier areas. Mosses form the dominant ground cover in the denser forests while lichens drape from trees and are occaisionally found on rocks. Shrubs such as salmonberry and blueberry; trees, including Pacific alder; and herbs, such as devils club are found in the open spaces. Skunk cabbage occurs in wet hollows. Heaths and herbs are found in stands with a high percentage of western hemlock.

The vegetation along the river channels which drain into Chatham Strait, Lynn Canal, and Taiya Inlet can be classified as riparian vegetation and further subdivided into: black cottonwood forest; shrub thickets; sparse, frequently-flooded stream channel; and vegetation.

Black cottonwood stands are found on the stabilized alluvial terraces. Willow and Sitka alder are also found within these riparian stands. Perennial herbs are found on coarse, unstable, frequently-flooded alluvium along the sides of the rivers.

Coastal vegetation along the coast of the Chatham Strait, Lynn Canal and Taiya Inlet can be classified as beach meadows; saline or brackish meadows; and freshwater marshes. Beach meadows are found above high tide along the more exposed gravelly and sandy beaches and rocky areas while saline or brackish meadows are found on fine-textured soils near mouths of rivers (see Map Addendum). Freshwater meadows or estuaries dominated by sedges are found on fine-textured materials near the mouths of rivers in areas that receive little or no saltwater inundation (see Map Addendum).

Recommendations for ecological reserve sites throughout the state were presented in 1977 and consisted of 223 sites. Eleven proposed ecological reserve sites are located along the tanker route in Chatham Strait, Lynn Canal, and Taiya Inlet (see table 8.2.2-3). At the present time it is uncertain what the boundaries of the units will be and which will receive official designation as reserve units.

TABLE 8.2.2-3
PROPOSED ECOLOGICAL RESERVES ALONG THE PROJECT ROUTE

Proposed Reserve	Location	Ownership
Tebenkof Bay	East side of Chatham Strait, 65 Miles southeast of Sitka	Federal
Port Walter	West side of Chatham Strait, 50 miles south of Sitka	Federal
Port Herbert	West side of Chatham Strait, 45 miles south of Sitka	Federal
Rowan Bay	East side of Chatham Strait, 50 miles southeast of Sitka	Federal
Yasha Island	Southern tip of Admiralty Island	Federal
Kootznakoo Inlet	West-central Admiralty Island	Federal
Auke Bay	10 miles northwest of Juneau	State
Benjamin Island	East side of Lynn Canal, 26 miles northwest of Juneau	Federal
Berners Bay/ Echo Cove	East side of Lynn Canal, 40 miles northwest of Juneau	Federal
Boat Harbor	West side of Lynn Canal, 36 miles northwest of Juneau	Federal
Taiya Inlet	Northeast arm of Chilkoot Inlet	Federal/State

TERRESTRIAL WILDLIFE

Areas of suitable habitat for various species of wildlife have been identified by the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, and the U.S. Forest Service. Many species tend to utilize more than one habitat type. A summary of the major wildlife species and habitats known to be in the area is presented in table 8.2.2-4. The extent to which wildlife utilize these habitats has not been quantified. Only the presence or absence of species and their habitat in a given vegetation zone is known.

Along the tanker route the Coastal Range is bisected by several river systems which provide access from the interior to coastal areas. The habitats available to wildlife on islands are similar to those on the mainland.

Brown bear, black bear, and Sitka black-tailed deer utilize coastal environments along the tanker route seasonally, while pine marten, mink, and land otter rely on marine food resources in their diets year-round.

The brown or grizzly bear utilizes several vegetation types from sea level to above timberline on the islands and mainland. Much of the area bordering Chatham Strait receives intensive brown bear usage during the spring months. Bluff Bay, Big Port Walter, Port Lucy, and Kelp Bay on Baranof Island; Tenakee Inlet and Freshwater Bay on Chichagof Island; and most of the west side of Admiralty Island are important brown bear habitats.

TABLE 8.2.2-4 MAJOR WILDLIFE SPECIES AND HABITATS - INSIDE CHANNEL

Habitat Type	Vegetation	Mammals	Birds
Western hemlock/ Sitka spruce Coastal forest	Coniferous forest dominated by western hemlock and Sitka spruce with some Alaska cedar and western red cedar	Black bear, shrews, brown bear, voles, pine marten, Sitka black-tailed deer, mink, land otters, weasels	Bald eagle, peregrine falcon
Grass/sedge meadow Coastal meadows	Vegetation (occurring on fine-textured coastal and deltaic sediments) primarily composed of beach ryegrass, sedge, alkali saltgrass, and halopytic herbs	Black bear, wolves, brown bear, voles, Sitka black-tailed deer, mink, land otters, shrews, weasels	Bald eagles, peregrine falcon, whistling swan, Canada goose, American widgeon, pintail, mallard, white-fronted goose, arctic tern, great blue heron, dunlin, common snipe, raven, western sandpiper, gulls, and several other species of waterfowl and shorebirds

Source: Selkregg 1974, Klinkhart 1973, 1978

The black bear utilizes the same habitats as the brown bear, including coastal meadows in the spring and salmon-bearing streams in the fall. Black bears are found frequently in forested areas on the mainland and intensely used areas on Kupreanof and Kuiu Islands.

The numbers of Sitka black-tailed deer fluctuate depending upon winter severity. Coastal fringe areas along the tanker route are important to Sitka deer survival. Optimal habitat is climax forest near the beaches. Populations are usually associated with the coastal western hemlock/Sitka spruce forests. During severe winters deer move to the open beaches to feed on dead grass, sedge, and kelp. Heavily utilized winter ranges include Bay of Pillars, Rowan Bay, Petrof Bay, and Saginaw Bay on Kuiu Island; the west side of Admiralty Island; the northeast side of Chichagof Island; Pleasant Island in Icy Strait; the west side of Douglas Island; and much of Lynn Canal. (Fish, Wildlife and Habitat Resources, Alaska Department of Fish and Game 4/1979).

Wolves are present throughout the tanker route area except on Admiralty, Chichagof, or Baranof Islands. Wolves use established hunting areas and are wide-ranging over a variety of habitats.

Moose populations are present along Taiya, Skagway, Ferebee, and Chilkoot Rivers and Lutek Inlet (Alaska Division of Lands 1978.) and Berners Bay (Alaska Department of Fish and Game 1979). Moose use a combination of coastal and interior habitats ranging from dense stands of Sitka spruce to cottonwood, alder, and willow valley areas. The lower regions of several valleys in Lynn Canal are important winter moose habitat. On the western side of the canal moose use wintering areas around St. James Bay and along the Endicott, Sullivan, and Chilkat River Valleys, and the Davidson Glacier drainage. Murphy Flats is a particularly valuable moose habitat.

The preferred summer range for mountain goats extends from timberline to about 5,000 feet of elevation. Most remain where food is abundant on the lower mountain slopes and near alpine meadows; winter range extends from sea level to timberline. Forest fringe areas along both sides of Lynn Canal are critical winter habitat for mountain goats. The most heavily used areas include the low timber fringe areas from St. James Bay to the Chilkat River on the west side and from Berners Bay to the Katzehin River on the east side.

Pine marten distribution is limited primarily to climax hemlock-spruce forests from sea level to timberline, although the pine marten often occurs along shorelines where it forages on marine invertebrates. Pine marten are abundant on Admiralty Island and occur on Chichagof and Baranof Islands.

Mink are usually associated with riparian habitats and a small stretch of forest-beach edge near streams, ponds, marshes, and saltwater beaches. The most suitable foraging habitats are relatively steep rocky beaches supporting high densities of intertidal food sources. Such areas also provide adequate security cover. Rock crevices and root cavities above suitable beaches provide critical denning habitats. Mink are common throughout Icy Strait, Lynn Canal, and Taiya, Chilkat, and Chilkoot Inlet.

River otter are abundant throughout Chatham Strait and Lynn Canal, preferring streams, rivers, or coastal shoreline areas. Other wildlife resources along the tanker route include furbearers such as lynx, coyote, red fox, and beaver, as well as small game species like porcupine, snowshoe hare, and several species of ptarmigan (Alaska Department of Natural Resources 1978).

The bays, coves, deltas, streams, and rivers throughout the inside channel provide pockets of waterfowl and shorebird habitat. Theses areas provide an extremely rich source of marine and freshwater foods for resident populations and play a vital role in the lives of millions of migratory birds that nest in less productive habitats above the Arctic Circle in northern Alaska, Canada, and Russia. The beach areas along the tanker route are considered to be critical waterfowl habitat.

Many divers and dabblers such as mallards and pintail, as well as swans and Vancouver and Canada geese are year-round residents in the coastal environment of Chatham Strait, Lynn Canal, and Taiya Inlet. Also, during late spring and through the summer concentrations of sea and diving ducks, Canada geese, and dabblers occur in herring spawning areas. River valleys, deltas, streams, and beach fringes along the proposed tanker route all support production of various species.

Diving ducks such as greater scaup, lesser scaup, common goldeneye, Barrow's goldeneye, and bufflehead utilize the area for migration and overwintering. Surf and white-winged scoters are found in the area. A flock of 70,000 scoters has been observed on the water near Benjamin Island in Lynn Canal. Year-round residents include common and red-breasted mergansers. Harlequin ducks use the area for nesting.

Whistling swans migrate through the area in spring and fall. Several hundred trumpeter swans also utilize the area. Vancouver and Canadian geese are year-round residents of this area, constituting perhaps 25 percent of the world-wide population.

The Arctic peregrine falcons are considered a rare and endangered species and occur in this area strictly as occasional migrants on their way to and from interior breeding grounds. Arctic peregrines have been sighted at various points along Chatham Strait and Lynn Canal but very little is known about their migration through southeast Alaska. There is probably no single major use area.

The Peales peregrine falcon is not considered a rare and endangered species and inhabits island and coastal regions along the tanker route. Unlike the Arctic peregrine falcon, the Peales peregrine is nonmigratory.

The bald eagle is not considered a rare and endangered species in Alaska due to its present distribution and estimated population density.

More bald eagles live in the forested areas of southeast Alaska than any other place in the world. Present surveys have identified 2,760 nests and indicated an estimated breeding population of 8,000 birds. Although bald eagles use a wide variety of habitats along the inside channel, they nest almost exclusively in tall trees within 600 feet of saltwater or along major river drainages. They are less common in sheltered bays and along unforested shorelines.

Admiralty Island supports an average of nearly two nests per mile of shoreline and is an important nesting area. At the confluence of the Tsirku (Big Salmon) and Chilkat Rivers more than 3,000 eagles congregate to feed on spawned-out salmon during the fall runs. This area has been designated as a critical river habitat area by the Alaska Department of Natural Resources.

During spring and fall migration periods waterfowl and shorebirds from the Pacific flyway use the coastal areas along the tanker route for resting and feeding. In the fall, most birds migrating to southern Pacific flyway areas stop only briefly or pass through on the outer coast. Many divers, mallards, pintails, and trumpeter swans remain to over-winter. During the spring most migrating birds utilize the available habitats for more extended periods.

This use of the migratory bird habitat is critical. Should any delay in the arrival of spring in northern nesting grounds be combined with an early fall, the nesting season could be shortened by as much as a month. This could result in less mature young and weakened adults not capable of long flight. A week or two in productive habitats enables birds to recover and continue on to wintering grounds.

Critical or sensitive habitats comprise areas which are highly important to the maintenance or survival of valuable or unique fish and wildlife species or populations. Although many areas within this region warrant this general definition, only a few have been legislatively designated by Alaska or the federal government. The following is a list of those areas which have been designated:

Mendenhall Wetlands State Game Refuge (State) - provides outstanding habitat for migratory birds.

Chilkat River Critical Habitat Area (State) - provides valuable salmon spawning habitat and a winter roosting area for bald eagles.

Glacier Bay National Monument (Federal) - provides a pristine habitat for abundant bird, fish, and marine mammal resources.

Admiralty Island National Monument (Federal) - provides nesting areas for bald eagles.

St. Lazaria Islands National Wildlife Refuge (Federal) - encompasses a major bird colony.

Hazy Islands National Wildlife Refuge (Federal) - encompasses a major sea lion hauling out area.

VISUAL RESOURCES

Visual analysis consists of the determination of the quality of two basic landscape characteristics. Scenic quality and visual sensitivity. Scenic quality is a measure of the potential for an aesthetic human experience based on landforms, patterns of vegetation, water features, and man-made structures and alterations. Scenic quality is rated as A/B or C; (see section 2.1 Visual Resources, Pipeline Systems). Zones for visual sensitivity are divided into a foreground-middleground visual zone (0 to 5 miles) and a background visual zone (5 to 15 miles). None of the proposed project is within a mandatory Class I federal scenic area.

Lynn Canal is a steep rugged saltwater fjord of a pristine visual nature. The canal is commonly traveled by fishing boats, cruise ships, ferries, and ore carriers (see photographs of channel). The surrounding mountains and the rugged character of the fjord give the area a unique quality.

LAND USE

Certain lands along the tanker route are subject to native claims; Hoonah, Angoon, and Kake are the largest. The village of Klukwan has elected to retain its status as an Indian Reservation. The status of native land selections in Alaska is subject to change through land exchanges and the eventual dropping of land claims which have been overselected.

RECREATION

The route from Cape Ommaney to Skagway is the northern portion of an extensive summer tourist route of cruise ships coming from Vancouver, San Francisco, and Los Angeles and of Alaska state ferries entering the Dixon Entrance of Alaska from Seattle and Prince Rupert, British Columbia. Tourist attractions along the route are both natural and cultural features. Tourists view rugged scenery, glaciers, expanses of primitive land, and find opportunities to photograph wildlife. Bald eagles and brown bears and marine mammals such as whales, sea lions and seals are commonly seen. Attractions in the coastal communities along the ship routes include artifacts and art forms of native Indian groups, and items of the Russian era.

Total summer (June through September) visitors to Alaska in 1977 were 320,979; 26 percent used cruise ships and 15 percent used the ferry liner. Almost all can be assumed to be marine-related tourist or partly tourist (as opposed to business) travel in the Inside Passage. One estimate indicates that 40 to 55 percent of all visitors to Alaska spend part of their stay in the southeast panhandle. After Juneau, Skagway and Haines are the important cruise ship ports.

Limited data on tourism indicates that the coastal zone is critically important to Alaska tourism and that the attractions are predominantly those values provided by untouched scenery, waterways, fish, and wildlife.

Most of the land bordering the tanker route is part of the Tongass National Forest, including Admiralty Island, which was recently declared a U. S. Forest Service National Monument. Glacier Bay National Monument, administered by the National Park Service, lies north of Icy Straits. In addition, a number of state parks or campgrounds lie close to the proposed tanker route. In Haines Borough these include Portage Cove, Chilkoot Lake, and Mosquito Lake campgrounds, and Chilkat State Park.

Recreational use of federal, state, and local areas in southeast Alaska in 1973 was approximately 1.8 million visitor days. Visitor days to Tongass National Forest for all activities totaled 1.3 million in 1975, of which 646,800 (49 percent) were within the Chatham area, Lynn Canal, and Stephens Passage.

The interlocking network of deep waterways which form the Inside Passage of southeast Alaska and the distribution of population in coastal communities make recreational boating an important activity and a means to gain access to other recreational areas. Table 8.2.2-5 shows the number of pleasure craft by location of registration. This is a minimum estimate because unmotorized craft (skiffs, canoes, kayaks and sail boats) and craft not in compliance with registration requirements are excluded. Commercial fishing boats (1,871), frequently used for recreational activities, and live-aboard boats (76) bring the total to 8,045. Clark and Lucas (1978) estimate approximately 14,000 registered boats in southeast Alaska or nearly double that estimated by the Alaska Department of Natural Resources. In addition to boats registered in Alaska, there are additional boaters from mainland U.S. and Canada.

A 1967 survey estimated that 59 percent of the southeast Alaska population (12 years and over) participated in motorboating, with an average annual rate of 19.3 days per participant. Within the Tongass National Forest, power boating accounted for 135,100 visitor days in 1975; canoeing, sailing, and other boating totaled 13,800 days.

TABLE 8.2.2-5 RECREATIONAL BOATING

Location	Number of Registered 1/ Pleasure Boats	Registration Per 100 Population	Index of Boat 2/ Concentration
Chatham Strait and Lynn Canal Vicinity			
Juneau	1,903	9.9	.86
Haines	157	7.4	.64
Hoonah	69	8.1	.71
Skagway	66	7.7	.67
Tenakee Springs	36	41.9	3.69
Kake	33	4.9	.42
Angoon	31	7.1	.62
Pelican	26	15.4	1.34
Gustavus	17	26.5	2.33
Elfin Cove	11	22.4	2.00
Port Alexander	3	5.9	.50
Other Locations in Southeast Alaska			
Ketchikan	1,701	15.1	.86
Sitka	725	10.2	.89
Petersburg	488	22.9	2.00
Wrangell	457	14.5	1.26
Annette and Metlakatla	146	11.7	1.02
Craig	35	7.5	.65
Klawock	23	8.1	.72
Hydaburg	14	3.6	.32
Yakutat	13	2.9	.25
Point Baker	13	37.1	3.00
Meyers Chuck	9	24.3	2.14
Kasaan	5	13.2	1.14
Hyder	3	6.1	.56
Miscellaneous (not-named) Locations	114	5.9	.51
Total	6,098	Average 13.6	

Source: Alaska Department of Natural Resources 1977

1/ Pleasure boats registered with U.S. Coast Guard. Excludes unmotorized craft and craft not in compliance with registration requirements.

2/ Index computed by Department of Natural Resources, Division of Parks. Equivalent to any location's percentage of total pleasure boats in Southeast Alaska divided by that location's percentage of Southeast Alaska's population.

Marine waterways, rivers, streams, and lakes of southeastern Alaska provide abundant opportunities for recreational fishing. Along or near the tanker route, fishing facilities (sports boats, pier fishing, launching, skiff rentals) are found at Angoon, Juneau, Douglas, Auke Bay, Tee Harbor, Hoonah, and Haines. Generally, the entire passage of the Lynn Canal and Chatham Strait can be considered a significant marine recreational fishing resource with the best sport fishing reported south of Haines.

Table 8.2.2-6 lists fishing days in 1977 for saltwater and freshwater fishing by geographic area. Saltwater fishing in these areas accounts for 55.5 percent of all fishing days in southeast Alaska or 73 percent of total saltwater fishing days. Approximately 56 percent of the resident southeast Alaska population (12 years and older) was estimated to participate in saltwater fishing at an average of 16.8 days per participant.

TABLE 8.2.2-6 SPORT FISHING DAYS (1977) SOUTHEAST ALASKA

	Saltwater			Freshwater			Total
	Boat	Shore-line	Principal Species Sought	Rivers and Streams	Lakes	Principal Species Sought	Days Fished
Area A	37,507	4,353	pink, king, and coho salmon	7,201	6,679	cut-throat trout, rainbow trout, dolly varden	55,740
Area B	5,652	363	coho and pink salmon	5,466 1/	562	cut-throat trout, rainbow trout, dolly varden	12,043
Area C	16,966	2,412	coho, king, and pink salmon	6,612	1,222	cut-throat trout and dolly varden	27,212
Area D	24,178	6,639	smelt, razor clams, pink salmon, rockfish, dolly varden, coho, and king salmon	3,776 1/	3,151	dolly varden, rainbow trout, and cut-throat trout	37,744
Area E	63,708	17,595	coho, king, and pink salmon, dolly varden, rockfish, red salmon, halibut	6,845	4,231	dolly varden, cut-throat trout, pink salmon	92,379
Area F	4,211	1,383	dolly varden, pink and king salmon	3,761	2,247	smelt, dolly varden, coho, pink, and red salmon	11,602
Area G	2,614	399	coho	332	1,030	dolly varden, coho	4,375
Area H 2/	350	492	halibut, coho	4,951	86	coho, dolly varden	5,879
Total	155,186	33,636		38,944	39,208		246,974

Source: Alaska Department of Fish and Game 1977

1/ Includes lake and river systems

2/ Includes all waters from Cape Suckling to Cape Fairweather.

Data for 1975 fishing licenses shows that 39 percent were issued to non-residents (Clark and Lucas 1978.) Salmon derbies held in Juneau, Ketchikan, Sitka, Haines, Petersburh, Craig, Wrangell, and Kake attract both residents and tourists.

For many residents and non-residents, hiking, beachcombing, mountain climbing, berry-picking, camping, winter sports, and hunting are popular activities. Both hiking and hunting are frequently dependent upon access by boat or float plane. In 1975, in the Chatham portion of the Tongass National Forest about 14,000 visitor days were spent in hiking, 40,000 in hunting, and 52,300 in camping.

Hunting days for types of game are inconsistently reported for those game management units which bound Chatham Strait and Lynn Canal. Admiralty, Baranof, Chichagof, and adjacent islands are particularly noted for high densities and good hunting of deer and brown bear: trapping for furbearers is currently low. Moose are hunted in the Juneau management unit as are deer, mountain goat, black bear, and some brown bear. Residents constitute the majority of hunters for moose in the Haines area and probably for goat as well. Guide service (required for non-residents who hunt big game) has increased in the ABC Islands. Estimates in 1974 indicated 51 percent of this unit's brown bear harvest was taken by non-residents. Non-resident deer hunting appeared quite small in 1976-1977.

In general, hunting for waterfowl is a significant coastal recreational activity with most activity occurring in the forest between Prince of Wales Island and Frederick Sound.

ECONOMIC CONDITIONS

The upper Lynn Canal region of southeastern Alaska is sparsely settled, with all towns but Skagway dependent upon the renewable resources of fishing and timber.

The smaller towns are predominantly inhabited by Alaska natives who are dependent upon the fisheries of Lynn Canal and Icy Strait for their economic livelihood. Recently the U.S. Forest Service has begun to move its staff from Sitka to Hoonah to oversee the logging operations on Chichagof Island. Hoonah has traditionally been a center for the regional commercial fishing and the shift to land-based forestry will create a radical change for the people of that community.

Alaska Department of Fish and Game limits the number of days and the location of commercial fishing. In 1977 two days per week were authorized during a 14-week season from July to October. Residents of these communities own boats, have permits, and work as crew. In addition to the commercial fisheries of the region, subsistence fishing is a crucial element in the lives of some residents. Data on the numbers and kind of catches are not available, but the streams and waters of Lynn Canal, Icy Strait, and Taiya Inlet are fished regularly by local residents for their own consumption.

The inland marine waters of southeastern Alaska support substantial commercial, sport, and subsistence fisheries. The Alaska Department of Fish and Game (ADF&G) has established fisheries management districts for southeastern Alaska (see Map Addendum). These management districts apply to all fisheries discussed below except halibut, which is controlled by the International Pacific Halibut Commission (IPHC). The proposed tanker route would cross four of these districts - Lynn Canal (115), Icy Strait (114), North Chatham Strait (112), and South Chatham Strait (109). The absence of data outside of these four areas should not be construed to mean that fisheries do not occur in other areas or that these other areas may not possibly be impacted. The four areas were selected because of their proximity to the proposed tanker route.

The inland marine waters support major commercial fisheries valued in excess of $76 million to fishermen and over $41 million to local fish processing facilities (see table 8.2.2-7). King, red, coho, pink, and chum salmon are harvested commercially. It is estimated that the annual salmon fisheries alone exceeds $13 million to fishermen and is in excess of $33 million to local fish processing facilities. The most intense commercial fishing activity occurs in Icy Strait and Lynn Canal.

Preliminary data indicate that the 1978 catch is the highest recorded salmon catch in Alaska since 1943 (Division of Commercial Fisheries, State of Alaska, personal communication). The value of the commercial catch is only a fraction of the value of the area to salmon resources. All the passages serve as migratory routes for salmon, which are harvested in other areas. Salmon also serve as food for many larger fishes and marine mammals, and during spawning are essential food to large numbers of terrestrial mammals and birds.

Herring, collected commercially by purse seines and gillnets, are harvested in most fishery management districts in southeastern Alaska (see Map Addendum). Herring are harvested for food and bait in Icy Strait and Chatham Strait, and for sac roe in Lynn Canal. Major herring fishing areas are also major spawning areas.

Two species of bottom fish, sablefish (black cod) and halibut, are harvested commercially in deep waters. Chatham Strait provides the bulk of the catch. Halibut are harvested throughout most of the area. Icy Strait is the area of the largest harvest.

Three species of king crab are harvested commercially, red king (73% of the catch), brown king (26%), and blue (less than 1%). Fishing for king crab occurs along nearly the entire length of the Chatham Strait/Lynn Canal Passage and along a major portion of Icy Strait. In most of the region habitats necessary for spawning, rearing, and migration are not known (ADF&G 1979). Production during the last 5 years (1973-1978) encompasses the lowest experienced by the king crab fishery. However, production appears on the upswing (ADF&G 1979).

Tanner and Dungeness crabs are harvested in most nearshore areas of the northern districts of southeastern Alaska. In the protected waters of Icy Strait, Chatham Strait, and Lynn Canal, the crab populations are harvested by small vessels. As with king crab, the commercial fishery for Tanner and Dungeness crabs occurs along nearly the entire length of Chatham Strait and Lynn Canal and along most of Icy Strait.

The major fishery for shrimp occurs outside the areas of Icy Strait, Chatham Strait, and Lynn Canal. Shrimp have been found in commercial quantities in much of northern southeast Alaska. However, limited harvesting and processing capabilities have inhibited the development of the shrimp fishery (ADF&G, 1979).

The economic value of the southeastern Alaska sport fishery is substantial. In 1973, the total southeastern Alaska sport fisheries was estimated to be about $10.6 million. This economic value applies to all southeastern Alaskan waters. Data specific to the four areas, Lynn Canal, Icy Strait and Chatham Strait (north and south), are not available.

TABLE 8.2.2-7 COMMERCIAL FISHERIES

Species	Lynn Canal Catch	Icy District Catch	N Chatham Strait Catch	S Chatham Strait Catch	Value to Fisherman (First Wholesale)	Value to Processing Facilities (Second Wholesale)
Salmon 1/						
King	1,750 2/	2,457 4/	988 4/	(6)		
Red	111,733 2/	180,392 4/	32,462 4/	(6)		
Coho	55,137 2/	94,404 4/	30,889 4/	(6)		
Pink	22,578 2/	2,345,787 4/	1,117,277 4/	(6)		
Chum	271,668 2/	570,180 4/	262,801 4/	(6)		
All	466,801 3/	3,256,220 5/	1,444,417 4/	141,670 7/	$13,175,500 8/	$34,256,400
Herring 9/	524,800	544,300	680,375	874,733	$ 242,000	
Bottomfish						
Sablefish 9/	1,960	57,340	297,240	389,540	$ 440,200	$ 1,144,500
Halibut 10/	19,500	929,700	137,300	70,250	$ 1,600,000	$ 4,160,000
Crabs						
King 11/	14,640	82,600	31,700	19,900	$ 246,000	$ 500,000
Tanner 12/	79,100	551,000	34,740	52,000	$ 395,000	$ 800,000
Dungeness 13/	55,700	114,620	42,900	10,400	$ 146,000	$ 300,000
				Totals	$16,244,700	$41,160,900

Source: Adapted from ADF&G 1979

1/ Salmon catch is in number of fish.

2/ Gillnet catch only; 1968-1977 data base.

3/ Gillnet and troll data combined; 1968-1977 data base.

4/ Purse seine catch only; 1964-1973 data base.

5/ Purse seine and troll data combined; 1964-1973 data base.

6/ Data not available by species.

7/ Purse seine and troll data; 1973-1977 data base.

8/ Value calculated as (average catch) x (average wt/fish) x (average price/lb. paid to fisherman).

9/ Catch is expressed in pounds; 1973-1977 data base.

10/ The management zones for halibut fisheries are established by the International Pacific Halibut Commission (IPHC) and are slightly different from those used by the Alaska Department of Fish and Game (ADF&G). Data from the IPHC is extrapolated to the management zones, used by ADF&G. Data base is from 1973-1977.

11/ Catch is expressed in pounds; statistics from 1973 to 1978; includes red, blue and brown King crab.

12/ Catch is expressed in pounds; statistics from 1973 to 1978.

13/ Catch is expressed in pounds; statistics from 1973 to 1977.

CLIMATE

Climate

Skagway has a predominantly maritime climate, characterized by cold winters and cool summers. Both rugged terrain and nearby bodies of water exert a fundamental influence upon the climate.

Daily and seasonal temperature variations are usually confined to relatively narrow limits by the maritime influences. Differences between daily maximum and minimum temperatures range between approximately 10°F in the winter and 20°F in the summer. The monthly normal temperature varies from 23°F in January to 58°F in July. The highest temperature recorded at Skagway was 92°F, and the lowest -24°F.

Precipitation at Skagway is influenced by topography. Moist air from the Gulf of Alaska must pass over the high terrain in Glacier Bay National Monument before reaching Skagway. This causes much of the moisture to condense and fall as precipitation over the mountains before reaching Skagway. As a result, Skagway receives about half the precipitation received by coastal locations.

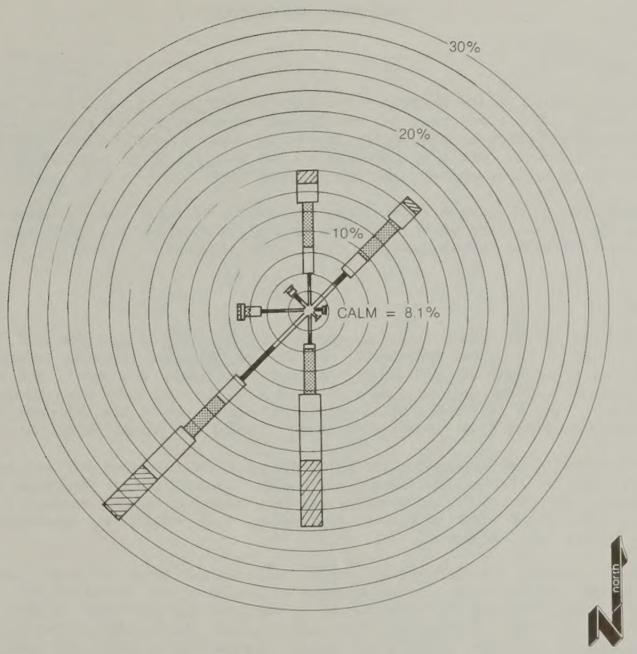
The average annual precipitation at Skagway is 26 inches, compared to an annual average of 54 inches at Juneau. The average monthly precipitation ranges from 5 inches in October to 0.9 inches in June. Annual snowfall averages 38.3 inches, with almost 50 percent coming during December and January. The maximum daily snowfall of 14.5 inches occurred in February 1922, and the maximum monthly snowfall of 40.2 inches was recorded in January 1944.

Available hourly meteorological data at Skagway is limited. The best data is composed of hourly observations measured between 0730 hours and 1930 hours from May 25, 1942 through December 31, 1942. A larger meteorological data base exists for Haines, where data is available for the years 1949 through 1952. However, topography is different so wind data is not similar.

The rugged terrain together with the straight channeling effect of the Taiya Inlet have a significant impact on the wind directions at Skagway. This channeling effect in the Taiya Inlet is shown in figure 8.2.2-5. Most (51 percent) winds during the summer months are from the south and southwest blowing up the Taiya Inlet toward the high mountains. Most common winter month wind direction (29 percent) is from the north and northwest with flow from the mountains down the Taiya Inlet.

This channeling of the winds also results in relatively high wind speeds. Fourteen percent of the wind speeds recorded at Skagway were greater than 24 miles per hour. The majority of these high wind speeds are associated with either the wind flowing up or down the Taiya Inlet. The maximum wind speed recorded was 44 miles per hour.

Fog reduced visibility to less than .5 miles at Skagway 0.9 percent of the time from May 25, 1942 to December 31, 1942.



FREQUENCY OF WIND SPEED AND DIRECTION

WIND INTENSITY SCALE

	☐	■	☐	▒	☐	▨
KTS.	1-3	4-6	7-10	11-16	17-21	> 21
M/SEC.	.5-1.5	2.1-3.1	3.6-5.1	5.6-8.2	8.7-10.8	> 10.8

WIND ROSE

SKAGWAY, ALASKA

MAY 25, 1942 - DEC. 31, 1942
0730 HOURS - 1930 HOURS

Figure 8.2.2-5

Dispersion Potential

Dispersion potential is a measure of the ability of the atmosphere to dilute emissions of pollutants. Parameters that determine dispersion potential include wind speed and direction, mixing height, and atmospheric stability.

A limited data base is available at Skagway for any of these parameters. Along with the wind data, ceiling height and cloud cover were recorded at Skagway from May 25 to December 31, 1942 between 0730 and 1930 hours. These data were used to estimate atmospheric stability. No mixing height measurements were available for Skagway.

The most common stability category at Skagway was D (neutral), occurring 79 percent of the time. This high frequency of the neutral stability is the result of frequent occurrences of cloudy conditions. Unstable conditions (A, B, and C) occurred 18 percent of the time, while the stable conditions (E and F) occurred 3 percent of the time (see table 8.2.2-8).

TABLE 8.2.2-8 FREQUENCY OF OCCURRENCE OF STABILITY CATEGORIES

Stability (Pasquill)	Frequency (Percent)	
	Skagway1/	Haines2/
A	0.3	0.3
B	7.9	4.8
C	10.0	8.6
D	78.7	66.2
E	0.9	5.3
F	2.2	14.8

Source: NEC 1979

1/ Period of record: May 25, 1942 - December 31, 1942 (0730-1930 hours)

2/ Period of record: January 1949 - December 1952

AIR QUALITY

Regulation of air quality in the Skagway area is under the jurisdiction of the Alaska Department of Environmental Conservation, Air Quality Division. Standards for air quality have been established by the federal government and the state of Alaska. (The federal standards are discussed in chapter 2.) The Alaskan standard corresponds to the federal primary (for the protection of human health) or secondary (for the protection of human welfare) standards, whichever is more stringent. In addition, Alaska has a standard for total reduced sulfur (TRS) of 50 micrograms per cubic meter for a 30-minute average.

The Prevention of Significant Deterioration (PSD) regulations discussed in Port and Onshore Storage Facilities, Air Quality, chapter 2, also apply for Skagway, which is presently classified as a Class II area. There are no existing Class I areas within

300 kilometers (200 miles) of Skagway; however, nearby Glacier Bay National Monument has been recommended for redesignation to Class I by the National Park Service.

The major pollutant at Skagway is particulates due mostly to fugitive dust and combustion sources. The particulate sources consist of unpaved streets, gravel parking lots, and wind-blown soils. The largest industrial sources of particulates are from the ore loading facilities, a railroad roundhouse heater, the town diesel generator, and a small incinerator. The town dump is periodically burned. Some particulates are released through the roof of the loading building when the ore cars are unloaded.

The sources of sulfur dioxide and nitrogen oxides at Skagway are the railroad, home heating by oil furnaces, trucks, automobiles, and a diesel power plant. Some emissions are produced by ships that dock at Skagway.

No air quality monitoring data exist for the Skagway area. In the absence of any major sources, the EPA (1978) assumes a concentration of 20 micrograms per cubic meter for both sulfur dioxide and nitrogen dioxide. It is reasonable to assume the ambient concentrations at Skagway are no higher than these values.

The sources of carbon monoxide at Skagway are those listed above for sulfur oxides and nitrogen oxides, particularly automobiles. Again, these emissions are small and the EPA (1978) background level of 1,175 micrograms per cubic meter is assumed.

The present estimated emission of hydrocarbons (a precursor to ozone formation) for two small tank farms located at Skagway was based on "Compilation of Air Pollutant Emission Factors" (Environmental Protection Agency Publication No. AP-42, Supplement 7, April 1977). None of the 30 tanks currently in use have air pollution control devices. Total emissions are estimated to be 89 tons per year from the heating oil tank farm and 93 tons per year from the Chevron ferry tank farm (NEC 1979).

NOISE

Daytime ambient noise levels in Skagway were monitored by the state of Alaska, Department of Highways and were found to be in the range of 50 to 55 dBA (Alaska DOT, 1973). A spot check of noise levels in Skagway conducted in March 1979 indicated that these levels of noise were still valid.

Several major noise sources exist on the Skagway waterfront. These include the White Pass & Yukon Route ore concentrate loading facility and freight wharf, other railroad operations, and the state ferry wharf. In addition, airplanes using the airstrip parallel to town and motor vehicles augment the noise levels.

Existing noise levels in the area of the proposed onshore storage facility are in the range of 40 to 50 decibels, with the primary sources being the Skagway-Carcross Highway traffic and the railroad shops (0.5 miles to the east). Planes using the Skagway airstrip (1 mile south) can occasionally be heard.

NEC states that the city of Skagway and the state of Alaska do not have any noise ordinances or laws applicable to its proposal.

TOPOGRAPHY AND GEOLOGY

Topography

Skagway is located on the Skagway River delta at the head of a fjord near the end of Taiya Inlet. The lower part of the Skagway River valley is steep sided with a relatively level floor. The valley is one of many in the region which has been scoured by glaciers, partially inundated by the sea, filled in with glacial outwash, and drained by braided streams (see the Map Addendum).

Within Skagway most of the level areas consist of alluvial terrace deposits. The onshore storage facility would be located on this level area, while the port terminal would be constructed at the base of a steep rocky headland.

Geology

Skagway lies within the northern portion of the Boundary Ranges province, near the western edge of the Coast Mountains. At Skagway, alluvial deposits predominate on the valley floor. Beach and delta deposits occur along the shore, and in places rockslide deposits and a thin veneer of glacial till mantle the lower slopes of the valley wall. It is inferred that at considerable depth below the alluvium, the fjord is filled with thick sequences of pleistocene glacial and marine deposits.

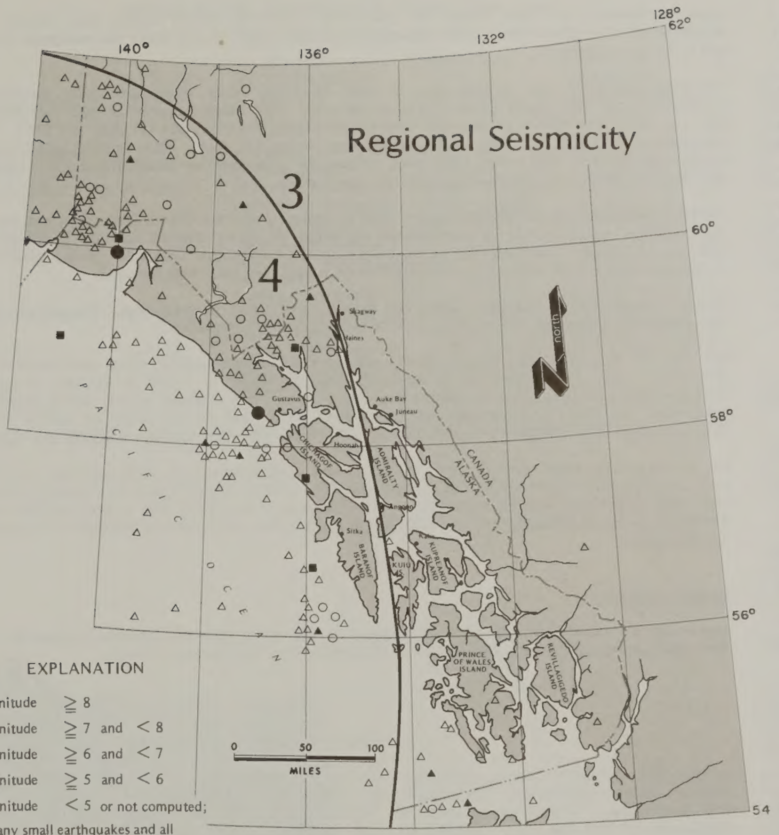
Holocene deposits in Skagway consist primarily of interfingerings and overlappings of various types of alluvial and deltaic deposits. Exposed marine sediments are rare. The complex arrangement of sedimentary layering suggests various stages of fluctuations in sea level after Wisconsin glaciation, with subsequent isostatic uplift, stream erosion and deposition.

The delta sequence consists of relatively well-sorted loose to dense mixtures of sand, gravel, and cobbles. Minor amounts of boulders and lenses of silt are also present. The thickness of these deposits averages approximately 30 feet, ranging from 10 to 50 feet. Geophysical data suggest that older offshore deposits extend to a depth of 145 feet where they contact pleistocene glacial and glacio-marine deposits. The bedrock bottom of the fjord lies at approximately 585 feet depth.

The bedrock of the headlands and valley walls consists of igneous and metamorphic rocks associated with the Coast Range batholith of late Mesozoic age. The igneous rocks are of granitic character surrounding highly deformed and altered metasediments. Locally, minor post-Cretaceous rhyolitic intrusives are evident with post-batholithic vein mineralization.

Skagway lies within a highly active tectonic belt of extensive faulting (see figure 8.2.2-6). The bedrock is complexly jointed, with dips ranging from near horizontal to vertical; strikes range from normal to ones parallel to topographic contours. Faults and joints have provided the lines of weakness upon which the existing topography has been developed.

The most prominent fault systems in the area are the Fairweather-Queen Charlotte Islands fault and the Denali fault. These are currently active within certain portions and exhibit right-lateral strikeslip movement. Diagonal to these major northwest-southeast faults are related faults striking generally north-south.



EXPLANATION

- ● Magnitude ≧ 8
- ■ Magnitude ≧ 7 and < 8
- ▲ Magnitude ≧ 6 and < 7
- ○ Magnitude ≧ 5 and < 6
- △ Magnitude < 5 or not computed; many small earthquakes and all microearthquakes are not included because of the lack of detection. Only earthquakes with a magnitude over 4 plotted after the year 1970.

Location accuracy

Optimum – 10 to 15 miles
Minimum – about 70 miles
Seismic Zone Boundary

Zone 3 Major damage possible to structures
Zone 4 Potential damage greater than Zone 8 due to geologic and tectonic factors
For more detailed information see section 2.1.1.12.

Figure 8.2.2-6

Skagway lies within a large region of earthquake activity which includes most of southeast Alaska and adjacent parts of Canada. Earthquake epicenters which have been instrumentally located in the area during the interval 1899-1973 are shown in figure 8.2.2-6, and table 8.2.2-9 provides a tabulation of dates and magnitudes of some earthquakes equal to or greater than magnitude 6 (Richter Scale).

Skagway is located within a zone of "major possible maximum damage to structures" (Avon undated). It is reported that the series of major earthquakes (magnitude 7.8 to 8.6) near Yakutat during September, 1899 were strongly felt at Skagway, with intensities estimated at approximately VII (Modified Mercali Scale). That intensity causes variable damage to structures. An intensity of VII was also estimated for the October 9, 1900 Icy Bay earthquake (magnitude 8.3). The most recent earthquake which caused damage at Skagway occurred on July 10, 1958.

TABLE 8.2.2-9 DATES AND MAGNITUDES OF SOME EARTHQUAKES

Designation on map	Date (Universal Time)	Magnitude
A	September 4, 1899	8.1-8.3
B	September 10, 1899	7.8
C	September 10, 1899	8.5-8.6
D	October 9, 1900	8.3
E	May 15, 1908	7
F	July 7, 1920	6
G	April 10, 1921	6.5
H	October 24, 1927	7.1
I	February 3, 1944	6 1/2
J	August 3, 1945	6 1/4
K	February 28, 1948	8 1/2
L	August 22, 1949	8.1
M	October 31, 1949	6 1/4
N	March 9, 1952	6
O	November 17, 1956	6 1/2
P	July 10, 1958	7.9-8.0
Q	July 30, 1972	6.5-7.5
R	July 1, 1973	6.1-6.7
S	July 3, 1973	6.0-6.4

Source: NEC 1979

Earthquake data strongly suggest that much of the seismic activity occurs along the Fairweather-Queen Charlotte Islands fault system. Surface rupture observed along onshore portions of the Fairweather fault segment of the system during the 1958 seismic event caused a maximum displacement of 21.5 feet along the fault and 3.5 feet vertically. Major earthquakes originating from this fault system are strongly felt at Skagway even at epicentral distances of more than 200 miles from the city.

Three nearly parallel northeast-trending lineaments in and near the lower Skagway valley area are inferred to be vertical or near vertical faults and are marked by pronounced linear topographic depressions. These inferred faults, one of which coincides with the lower Skagway valley, are in a generally northeast direction and are parallel to the rock joint system. Strike slip faulting is indicated by field evidence at White Pass.

There is no evidence of movement or displacement of Quaternary deposits in the Skagway area, indicating that the fault systems in the Skagway area may be inactive. The Chilkat River fault may, however, be tectonically active, as indicated by the March 9, 1952 earthquake of magnitude 6.

Geologic Hazards

Ground shaking during an earthquake is generally greater in geologic materials which are loose, soft, unconsolidated, and water saturated; conversely, shaking is much less on materials which are hard, firm, and unfractured, such as bedrock. During an earthquake the strongest shaking will occur in man-made fill, deltaic deposits of the interitidal zone, Skagway river alluvial deposits, colluvial deposits, and beach deposits. Less severe shaking will occur in the alluvial fan and drift deposits. The least amount of shaking will occur in sound rock.

Strong shaking and cracking of the deltaic deposits and river alluvial deposits upon which most of Skagway is sited, may be expected during major earthquakes. Strong ground shaking and cracking of river alluvium has been observed at Dyea.

Severe shaking of colluvial deposits is also expected during earthquakes. The Uniform Building Code places the city of Skagway on the borderline between zone 1 (Intensities V and VI) and zone 2 (Mercali Intensity VII). Figure 8.2.2-6 shows Skagway to be in zone 3 (magnitude of largest probable earthquake [LPE] greater than 6.0) but closely adjacent to zone 4 (potential damage greater than Zone 3 due to geologic and tectonic factors). Earthquake induced accelerations at ground surface on colluvial, alluvial, and deltaic deposits were inferred to be in the range of 0.10g to 0.15g during major earthquakes which have caused damage to structures in the city. Accelerations up to 0.5g might be expected in the event of a LPE with a nearby epicenter.

Differential settlement caused by compaction of loosely deposited deltaic and alluvial strata during an earthquake may be expected to occur.

Landslides and subaqueous slides of various types may occur during major earthquakes which are strongly felt in Skagway.

The active front of the Skagway delta may be susceptible to sliding during an earthquake. A failure of part of the Skagway delta front is inferred during the earthquake of September 16, 1899, when the outer end of a former wharf sank into the water. A major earthquake could cause landslides, ranging from rock falls to major movements, in colluvial deposits; such failures were observed during the earthquake of 1958. Landslides or subaqueous slides at other locations along Taiya Inlet could also effect the port of Skagway as at Lituya Bay, where wave runup has exceeded 1,700 feet above sea level.

Ground shaking during major earthquakes may cause "liquefaction" of fine grained deposits with a uniform grain size. If liquefaction occurs in sediments that have no lateral restraint, such as along delta fronts, material will tend to flow toward a free face and continue to flow as long as the ground continues to shake. Excess pore water pressures in fine zones of colluvial material below water may reduce the strength of the slope such that subaqueous slides will occur when the natural slopes are 2 to 1 or steeper.

Tsunamis (seismic sea waves) are a type of long water wave generally caused by earthquakes on the ocean floor. It is reported that Skagway experienced tsunamis on May 22, 1960 and March 27 and 28, 1964; and a possible tsunami on July 9, 1958. The maximum wave height of the 1964 tsunami was about 10 feet. The July 9, 1958 wave, which was 20 feet high, may have been caused by a submarine landslide as it preceded the smaller waves caused by the July 10 earthquake.

Jointed bedrock, particularly above the proposed port facility, may be expected to fall, either as a result of earthquake activity or other causes such as freezing and thawing of water in fractures. A rockfall at this location in recent years punctured a storage tank, releasing 360,000 gallons of gasoline into the harbor.

Slope failure in the Skagway area may occur from delta development, heavy rainfall, and seasonal freezing and thawing, as well as from earthquakes.

Failure of the Skagway River delta front from causes other than earthquakes is possible. The likelihood of a major failure is slight. Such a failure has been inferred by the breaking of submarine cables near the Skagway river delta front on September 10, 1927. The steep natural slopes above and to the south of the existing freight wharf are subject to rock falls. The submarine slopes are subject to slides.

It is reported that two floods which caused some damage to Skagway--one in 1901 and another in 1909--were caused by sudden outbursts of glacier-dammed lakes. Two such lakes have been identified near Skagway. However, the potential for such flooding is considered to be low and depends upon the continued stability of glaciers in the area.

Mineral Resources

There are no known ore deposits in Skagway. The only economic mineral resources are sand and gravel which are currently excavated along the Skagway River.

SOILS

Within the Boundary Ranges province the majority of the soils are derived from similar parent materials. They have been subjected to the same climate and weathering processes. Variation within the soils types are, therefore, limited to the influence of the degree of weathering and the topography. Only a Great Groups soil classification has been made in the general area.

The soils and their general properties within the project area are shown in table 8.2.2-10. Lithosols are soils without distinct horizons that consist mainly of hard rock with thin soil, broken rock and boulders.

Where soil covers the rock surface, wind and water erosion susceptibility is high. Mass wasting of soil and weathered rock is a potential when vegetation is disturbed.

TABLE 8.2.2-10 PROPERTIES OF SKAGWAY AREA SOILS

Great Groups	Proportions (Percent)	Relief and distribution pattern	Variations and inclusions	Presence of permafrost and others
Lithosol (with glaciers and snowfields)	40 - 50	Lithosol and Alpine Meadow soils associated with bare rock and highest mountains; Tundra and Half Bog soils generally on less steep slopes and lower mountain slopes; Bog and Podzol soils generally near the timber line and below.	Fresh alluvium, bare rock outcrop, large areas of snow and ice.	Bedrock is generally unfrozen, but soil cover is frozen in parts of Alaska Range, generally unfrozen in coastal ranges except on high mountains; permanent snow and ice conspicuous.
Mountains Tundra and Half Bog	20 - 30			
Bog	10 - 15			
Alpine Meadow	10 - 15			
Alluvial	5 - 10			
Regosol	5 - 10			
Weak Podzol	5 - 10			

Source: USDA Monograph No. 7 1950

AQUATIC RESOURCES

Physical Components

Drainage at the proposed onshore storage facility and along the proposed 3.5 mile unloading pipeline route from the proposed port facility flows into the Skagway River. This section of the river consists of several braided channels with predominantly sand, gravel, and cobble bottoms. Stream gradient varies from 5 feet per mile near the mouth to 50 feet per mile near the proposed onshore storage facility. Streambed composition and gradient were inferred from slope information and topographic maps. Water quality is generally good to high with naturally occurring high suspended sediment concentrations. Information concerning width, depth, velocity, gradient, composition, and scour depth for the crossing area is unavailable. Stream discharge information and water quality data are presented in tables 8.2.2-11 and 8.2.2-12 and were recorded near the proposed onshore storage facility.

TABLE 8.2.2-11 SKAGWAY RIVER DISCHARGE DATA[1]

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Annual
1977													
Mean	278	333	100	69	102	72	186	521	1841	2242	2129	795	727
Maximum	705	1580	173	93	125	82	567	1430	2620	2880	3170	2960	3170
Minimum	123	106	67	59	76	61	66	208	1010	1630	880	414	59
10-Year Mean (1963 to 1973)	360	151	56	30	33	34	66	422	1363	1497	1151	794	498

Source: Adapted from U.S. Geological Survey 1978 and Meyers and Harris 1974

[1] Discharge in cubic feet per second measured at Skagway.

The water supply for Skagway comes from three shallow wells (40 to 60 feet deep) sunk into alluvial deposits. High quality water comes from these wells and requires no treatment. The water table is near the surface and is recharged by the Skagway River, local precipitation, and snow melt.

Biological Components

Fishery resources in the Skagway River include chum salmon, coho salmon and Dolly Varden trout. Steelhead and cutthroat trout may also be present. Specific spawning sites, rearing areas, or population sizes have not been identified. Freshwater life history phases are presented in figure 8.2.2-7.

Aquatic insects in the river include mayflies, damselflies, dragonflies, stoneflies, and caddisflies. These insects serve as food for juvenile salmon and trout. Aquatic vegetation includes pondweed yellow pond lily, and water milfoil.

TABLE 8.2.2-12 SKAGWAY RIVER WATER QUALITY CHARACTERISTICS

(Concentrations in Milligrams per Liter)

Date of Collection	Discharge (ft^3/s)	Temperature (°C)	Silica ($Si0^2$)	Iron, Total (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids	Hardness as $CaCO_3$ Total	Non Carbonate	Specific Conductance (Micromohs at 25°C)	pH	Color
03-24-66	1/23	0.5	3.9	--	-0-	5.6	5.8	1.8	1.6	39	-0-	8.2	1.8	.2	.8	48	59	27	92	7.5	--
06-14-68	2200	5.0	2.0	1.2	-	4.2	.8	.5	1.1	20	-	0	.2	.2	.3	20	14	0	32	6.2	20
06-25-69	1280	8.5	1.7	.03	-	4.6	.7	.5	.8	16	-	1.4	.7	.1	1.3	20	14	2	32	7.3	10
09-04-69	504	7.0	1.9	--	-	6.2	1.2	.5	.8	22	-	1.0	1.1	.1	--	25	20	2	45	7.4	05
05-24-72	221	3.5	3.2	.14	.02	8.7	.9	1.2	.8	25	-0-	4.6	2.1	.3	29	36	25	5	56	6.5	20

Source: NEC 1979
1/Main daily discharge rather than instantaneous

Skagway, Alaska Bureau of Land Management

TIMING OF SEARUN TROUT AND SALMON FRESH WATER LIFE PHASES in the SKAGWAY RIVER

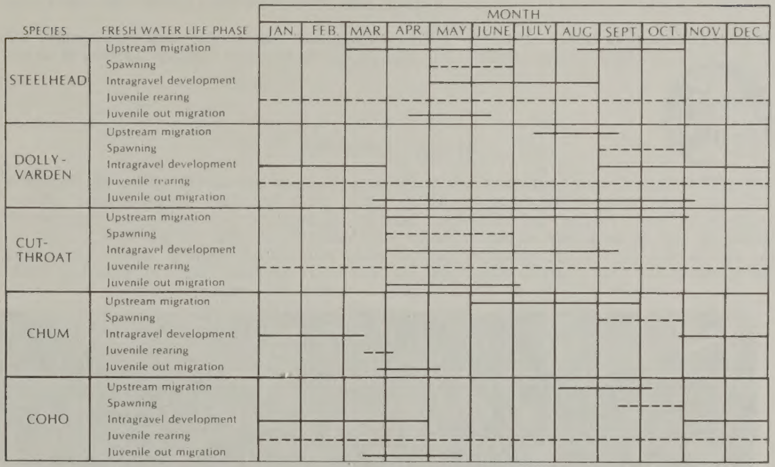


Figure 8.2.2-7

Sources
William R. Meehan - 1974
Theodore F. Meyers and
Reed F. Harris - 1974
Robert F. McLean and
Kevin J. Delaney - 1978

MARINE RESOURCES

Physical Resources

The mean diurnal tidal ranges (mean lower low water to mean higher high water) is 16.7 feet at Skagway. Extreme high tide for Skagway is 23.4 feet and extreme low tide is 6 feet.

Some measurements of trace metals in the sediments of Skagway Harbor have been made (Alaska Department of Environmental Conservation 1976) and are presented in table 8.2.2-13 and figure 8.2.2-8. The extremely high concentrations at sampling station 2 are probably due to the methods used in loading zinc, lead, and copper ore and ore concentrate at the pier. Asbestos fiber is also loaded there. These trace metal concentrations decrease with increasing distance from the pier. It is likely that these concentrations in harbor sediments contribute to the concentration of these metals in the water column above the sediments. These metals exhibit toxicity to varying degrees and are likely to be entering the food web and affecting both the benthic and the pelagic habitat. The Alaska Department of Environmental Conservation plans to conduct further sediment studies in the area concerning trace metal concentrations.

Biological Components

Refer to Biological Component in Sea Leg section.

TABLE 8.2.2-13 TRACE METAL CONCENTRATIONS IN SKAGWAY HARBOR SEDIMENTS1/
(Parts per Million Dry Weight)

Station Number	Copper	Lead	Zinc	Silver	Arsenic	Cadmium
1	30	704	730	1.0	1.5	1.0
2	666	13,625	26,000	35	12.6	33
3	28	434	405	1.0	1.34	0.6
4	47	498	535	3	1.95	3
5	37	311	340	4	1.6	3
6	16	148	185	0.5	0.75	0.1
7	7	60	70	0.3	-0-	-0-
8	4	9	30	0.15	-0-	-0-
9	4	14	35	0.13	-0-	-0-
10	8	50	95	0.25	0.14	0.1
11	18	94	165	0.35	1.1	0.1
12	41	230	250	1.2	1.1	0.7
13	8	42	70	0.3	0.64	0.1

Source: Alaska Department of Environmental Conservation 1976
1/ Analyzed by atomic absorption spectrophotomety.

TERRESTRIAL VEGETATION

Dense forests dominated by western hemlock and Sitka spruce are found above the high tide line near Skagway. The best developed forests grow just above high tide line with height of trees, timber volume, and quality decreasing progressively upslope.

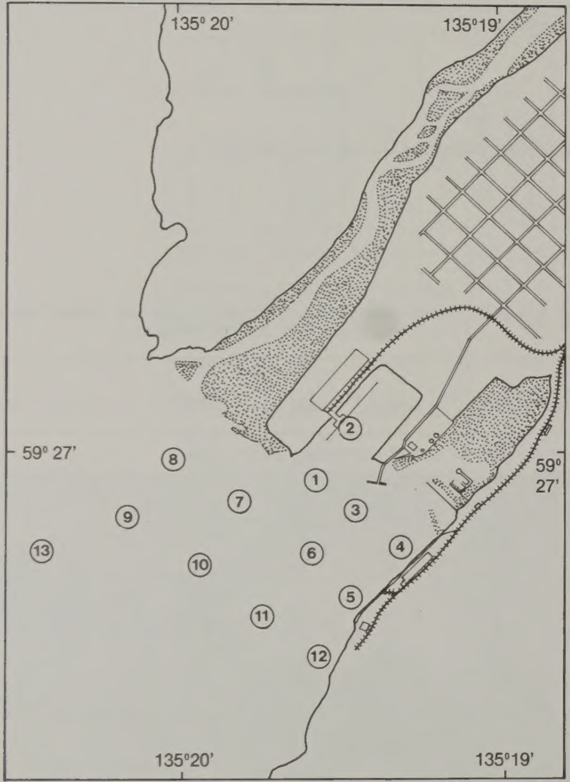
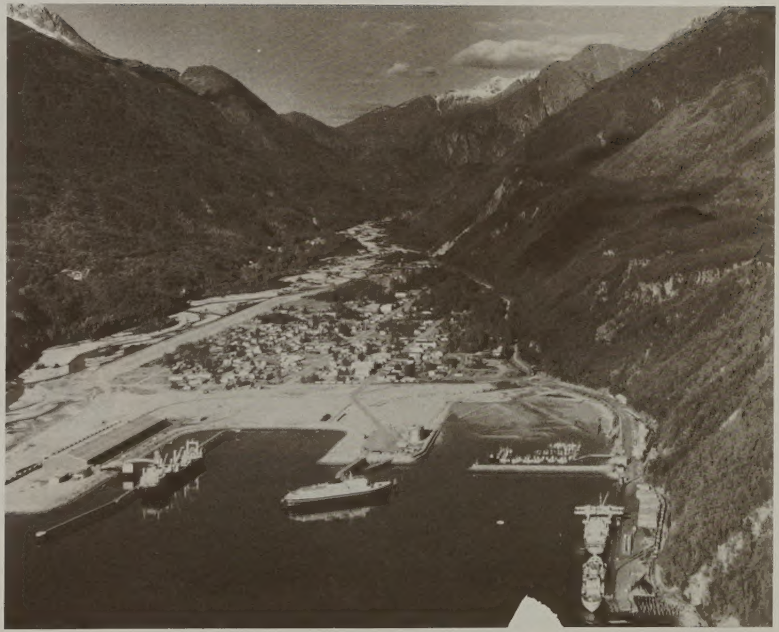


Figure 8.2.2-8

TRACE METAL SAMPLE SITES



Skagway harbor

Dedman's Photo Shop in Skagway, Alaska

The average productivity of the forests in the vicinity of Skagway is about 30,000 board feet per acre (Hutchinson and LaBau 1975).

The riparian vegetation along the Skagway River includes black cottonwood forest; shrub thickets; sparse, frequently-flooded stream channel; and vegetation.

TERRESTRIAL WILDLIFE

Areas of suitable habitat for various species of wildlife have been identified by the Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, and the U.S. Forest Service. Many species tend to utilize more than one habitat type. A summary of the major wildlife species and habitats known to be in the area of the proposed port and onshore storage facilities is presented in table 8.2.2-14. The extent to which wildlife utilize these habitats has not been quantified. Only the presence or absence of species and their habitat in a given vegetation zone is known.

TABLE 8.2.2-14 MAJOR WILDLIFE SPECIES AND HABITATS—
PORT AND ONSHORE STORAGE FACILITIES

Habitat Type	Vegetation	Mammals	Birds
Western hemlock/ Sitka spruce Coastal forest	Coniferous forest dominated by western hemlock and Sitka spruce	Red squirrel, voles, and shrews; major mammals absent	Bald eagle (probable), and passerine species
Black cottonwood Riparian	Riparian vegetation dominated by black cottonwood with some willow and alder species	Voles and shrews, snowshoe hare; major mammals absent	Bald eagle (probable), waterfowl, shorebirds, and passerine species

Source: Selkregg 1974, Klinkhart 1973, 1978

Wolves are present in the Skagway area. They use established hunting areas and are wide-ranging over a variety of habitats.

Red squirrels, voles, shrews, mice, and other rodents are the primary species readily adaptable to human presence and have the highest utilization of habitats in the vicinity of Skagway.

Raptors have not been formally surveyed in the area of the proposed facilities or adjacent habitats. It appears there is only low utilization. The bald eagle is known to occur in the Skagway area and existing concentrations are reported to be increasing. Present eagle nesting densities are estimated to be low (less than one per mile of shoreline), but exact nesting locations have not been identified.

Waterfowl and shorebirds are present primarily during spring and fall migration periods as no nesting or molting areas have been identified near Skagway. The Taiya River delta, Nahku Bay, and Skagway River are areas of high concentration during these periods.

CULTURAL RESOURCES

A preliminary archeological, historical and paleontological site survey was commissioned by NEC to assess the cultural resources in the vicinity of the proposed port and onshore storage facilities.

Prior to the arrival of Euro-American settlers the area of Skagway was claimed by the Tlingit Indians, and indications are that they used the area seasonally although there was some year round usage.

The first settler in the area arrived in 1887. The year 1895 was the first year of permanent occupation. Skagway was originally a tent town, but tents were quickly replaced by frame buildings. By 1898 Skagway began to decline as the center of mining interest shifted from the Klondike to Nome. By 1910 Skagway had shrunk in size from a population of 10,000 to 600, and from 1910 to the 1920s Skagway deteriorated and a depression settled on what was left of the business community. Things began to pick up during World War II when the CANOL pipeline, serving the Yukon Territory, was built by the military. Today Skagway serves as the port for the Yukon Territory and as a major tourist center.

The entire waterfront area (figure 8.2.2-9) has been affected almost continuously since the coming of whites. Construction activities have destroyed all evidence of historically significant features.

Specific features worthy of mention are on the eastern shoreline of the waterfront where the wall of the cliff is covered with painted designs, which for the most part correspond to ship logos. The earliest noted was done in 1927. There is a tradition of rock painting in Skagway and pictographs serve as tourist attractions.

The lower section of the Skagway river floodplain to the southwest of the airport runway has been disturbed extensively. What appears to be the remnant of an old protective levee is littered with metal debris. Bulldozing activities have added to the destruction of historic features by removing gravel from some areas and filling low areas elsewhere. No significant historical features were observed.

A single, partially buried railroad car was located adjacent to the main river channel at a point approximately opposite 11th Avenue. Further upstream, a wooden structure located near the center of the present river channel may represent a remnant of an old wagon road that existed in 1898. This bridge remnant is the only significant cultural feature located along the Skagway river adjacent to the city.

The only significant cultural feature observed on the alluvial flat south of the onshore storage facility is an old trash dump where there are the remains of debris that could date to the early part of the 20th century. The southwestern portion of this flat contains swampy areas. There exists a distinct possibility for encountering paleontological remains buried in the stratified alluvial sediments. Layers of compressed wood and charcoal are common where vertical exposures can be observed.

Skagway, Alaska

Northwest Energy Company

City Hall in Skagway, Alaska

Northwest Energy Company

CITY OF SKAGWAY AND THE LOWER SKAGWAY RIVER VALLEY

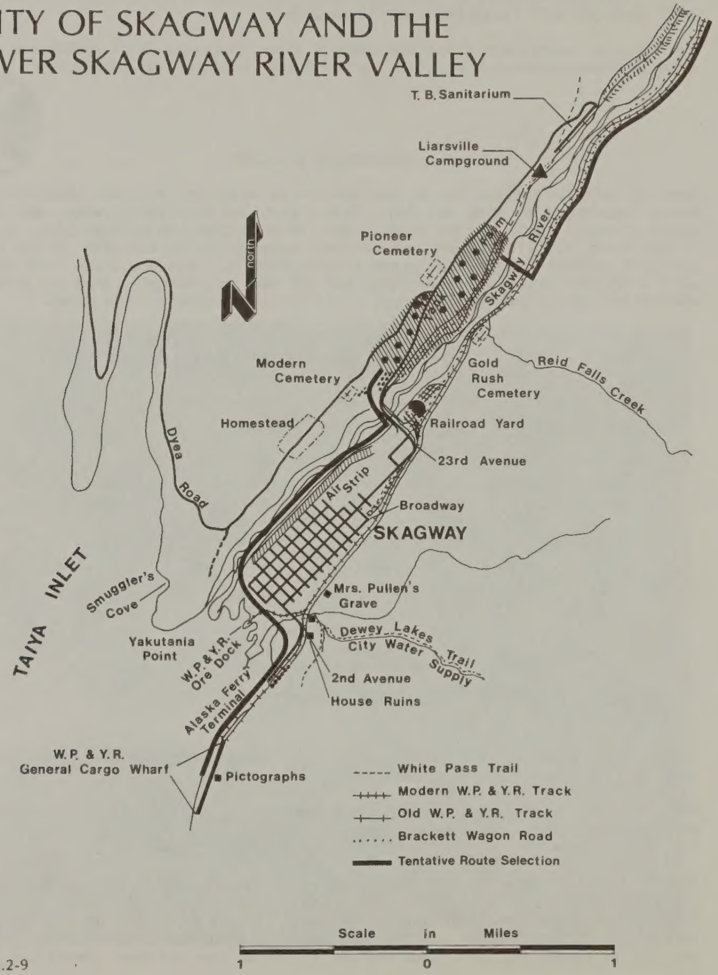


Figure 8.2.2-9

No cultural features were observed from the southwest end of this alluvial flat to the river mouth.

The section of the city from the airport strip to Spring Street is under National Historical Landmark status with specific structures listed on the register. The route of the proposed unloading pipeline would not affect this area. The National Park Service is currently involved in acquiring buildings for the Klondike Gold Rush National Historical Park.

The present city dump and a cemetery are located along the east edge of Dyea Road. Native Americans as well as whites are buried here. Gravestone dates range from 1926 to the late 1960s.

Remnants of the upper railroad bridge are found on the floodplain to the north of Skagway. Large stretches of the original railroad bed exist along the river in the vicinity of the existing onshore storage facility. Although portions of the old railroad bed have been destroyed by river erosion or by modern machinery, enough of it remains to establish clearly the integrity of the former railroad. This is the most significant historical feature remaining along this portion of the river valley (see figure 8.2.2-10).

Although no specimens were observed, scattered paleontological remains might be encountered in the sediments of sandy alluvium in the area.

As it leaves town the new highway to White Pass apparently follows exactly the old White Pass Trail along the west side of the river. Thus, the White Pass trail has been totally destroyed in this vicinity. The White Pass Trail turned downslope near Porcupine Creek and continued to the valley floor near the mouth of this creek. From here it progressed northward along the Skagway river, crossing it several times in a distance of about 2 miles. Remnants of this portion of the White Pass Trail still exist on the valley floor.

A tuberculosis sanitarium was established and operated between 1945 and 1947 adjacent to the northeast end of the existing onshore storage facility. Remains of buildings and roads associated with the sanitarium extend for about 1 mile along the edge of the old railroad bed in this vicinity (see figure 8.2.2-9).

No prehistoric archeological sites, fossil localities, or bone beds have been reported for the area of the proposed onshore storage facility. Igneous rock in the canyon side walls would preclude the discovery of fossil forms.

VISUAL RESOURCES

Visual analysis consists of the determination of the quality of two basic landscape characteristics: scenic quality and visual sensitivity. Scenic quality is a measure of the potential for an aesthetic human experience based on landforms, patterns of vegetation, water features, and man-made structures and alterations. Scenic quality is rated as A/B or C; (see section 2.1 Visual Resources, Pipeline System). Zones for visual sensitivity are divided into a foreground-middleground visual zone (0 to 5 miles) and a background visual zone (5 to 15 miles). None of the proposed project is within a mandatory Class I federal scenic area.

LOWER SKAGWAY RIVER VALLEY
23rd AVE. TO MILE 5 W.P. and Y.R.

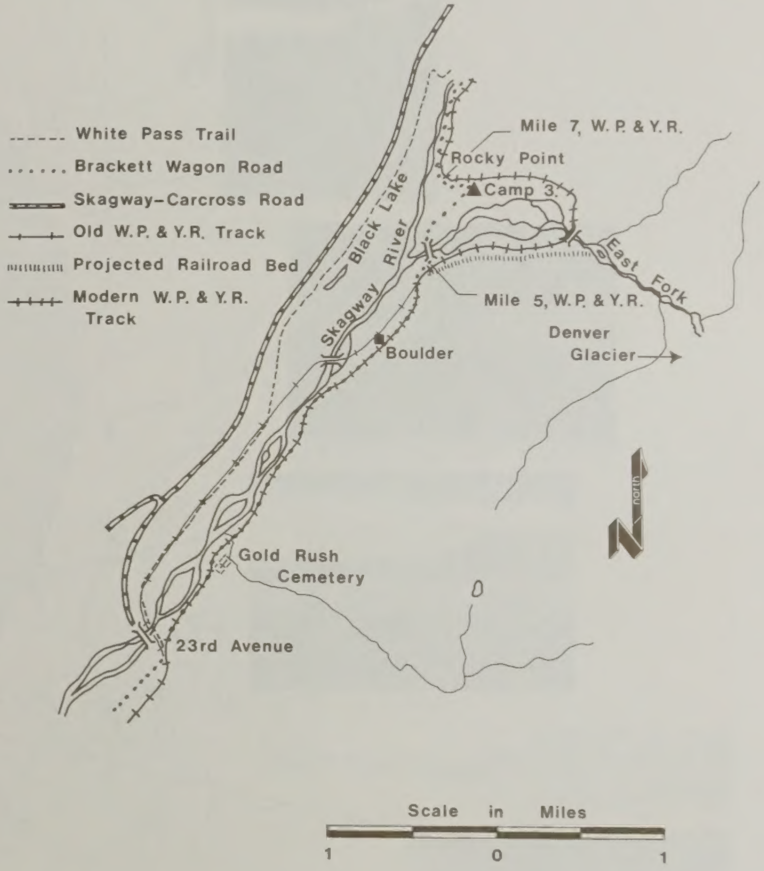
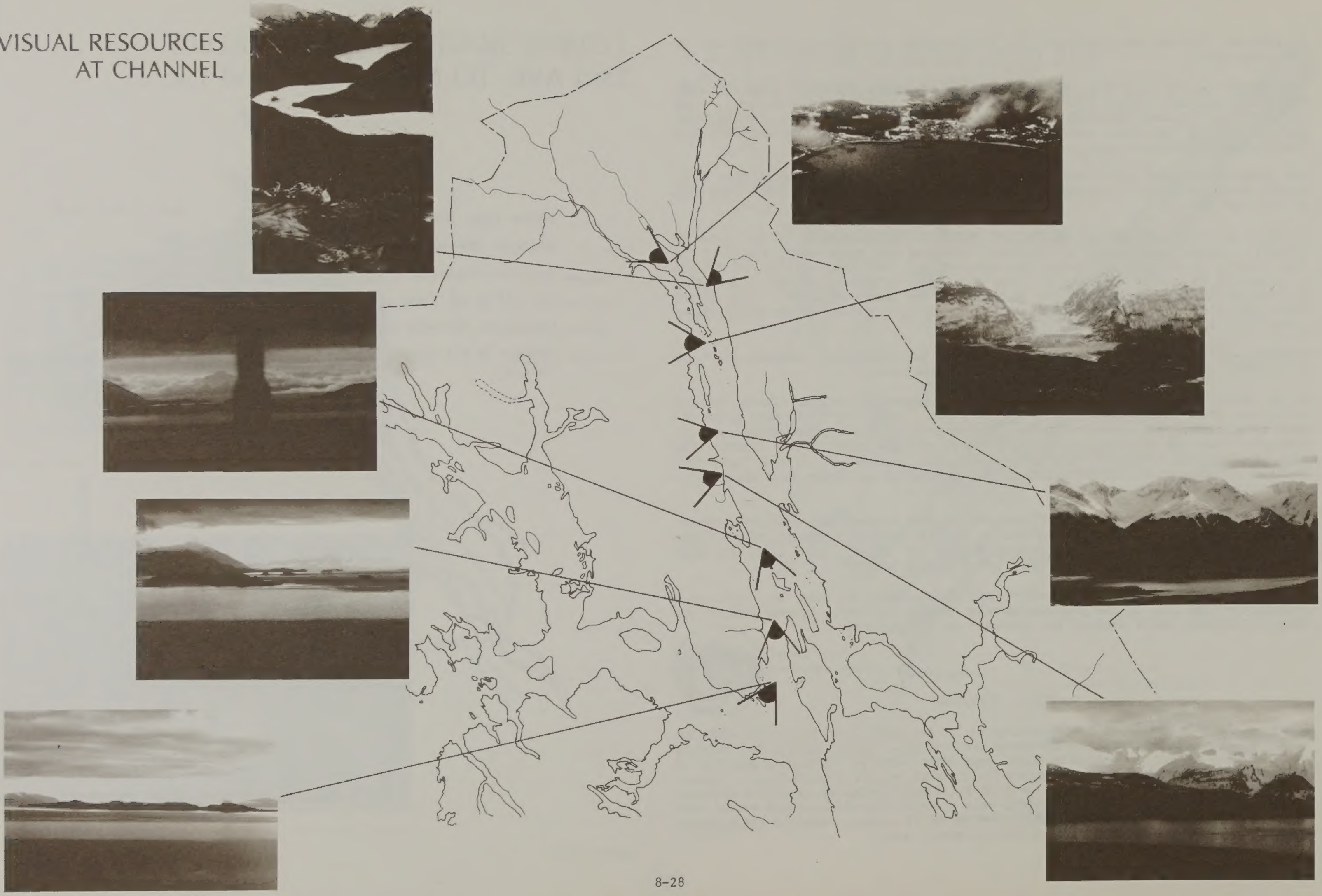


Figure 8.2.2-10

VISUAL RESOURCES AT CHANNEL



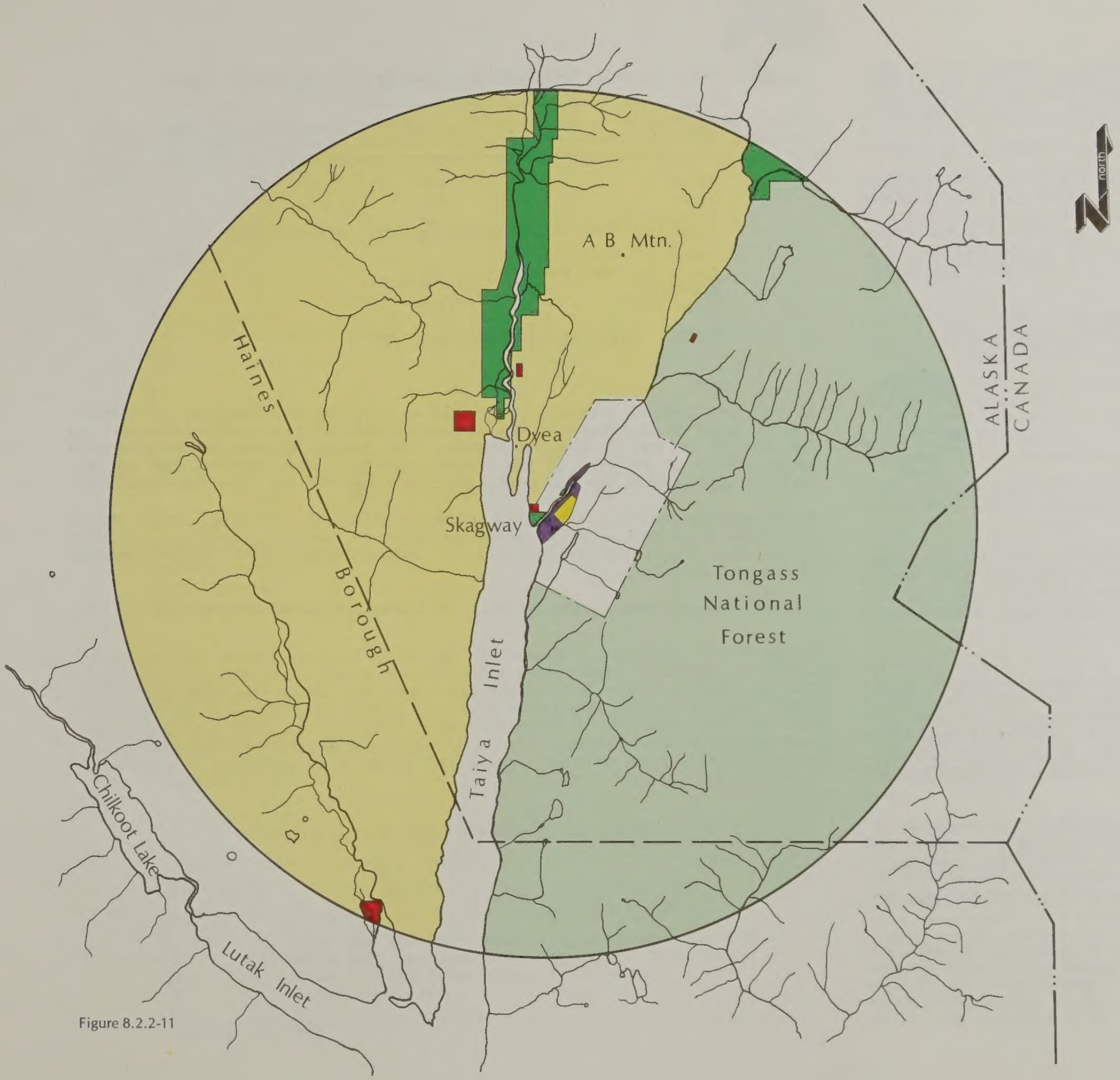


Figure 8.2.2-11

LAND USE AND OWNERSHIP OF SKAGWAY AREA

- 🟨 State Land Selections
- 🟥 Land Subject to Native Claims
- 🟩 Parks
- 🟪 Industrial
- 🟨 Urban (Commercial/Residential)
- —·— City of Skagway

1 ½ 0 1 2 3 4 5 miles

Views of the proposed port facility would be mainly from marine vessels and aircraft coming into Skagway. It would also be seen from Yakutania Point, the highway overlook, the ferry wharf, and ore concentrate loading facility. Views are generally unobstructed for observers at all these points; the port facility would be in the foreground-middleground visual zone (see photographs of Skagway and harbor).

The site proposed for the onshore storage facility is at the existing tank storage site where the terrain is flat to gently sloping. It is wooded with second growth deciduous species about 40 to 50 feet tall. The existing oil storage tanks are 24 feet high and 55 feet in diameter. The Skagway River is on the east and a stream, wooded slope, and highway on the west. The proposed site is obscured from most vantage points, except from the Skagway-Carcross highway bridge over the Skagway River.

From most vantage points the background zone has a high A/B rating. The proposed construction sites and much of Skagway have already been severely impacted, giving the visual sensitivity of the foreground-middleground area a scenic value of moderate to low rating.

LAND USE

The existing port consists of an ore concentrate loading facility, a state ferry terminal, a general freight wharf, a cruise ship facility, and a small boat basin. Work is presently under contract for a city barge slip.

The port is used for industrial, recreational, commercial, and transportation purposes. The principal industrial use of the port is as an ore concentrate loading facility. The principal transportation use is a passenger and vehicle ferry system. The city operates a 75-berth small boat harbor which is scheduled for relocation and expansion.

The existing land use pattern within Skagway is shown in table 8.2.2-15. A major portion of the land area is undeveloped because of steep slopes, the Skagway river, and the limited development potential of land on the outskirts of the central city. Residential and commercial properties are concentrated in the area just north of the port facility, including the Historic District. Industrial development consists primarily of the port, the White Pass and Yukon Route, and the airport. There is limited additional land available for further industrial development in the city.

The most recent land use inventory for Skagway was done in 1964 (see table 8.2.2-15). Aerial photographs and field surveys indicate the overall land use pattern has remained essentially the same. Skagway recently annexed the primarily mountainous land adjacent to the city, which includes an existing onshore storage facility and land owned by White Pass and Yukon Route. The annexation has increased the land area of Skagway to approximately 6,000 acres.

The existing land use pattern within a 10-mile radius of the proposed port and onshore storage facilities is presented in figure 8.2.2-11. Urban development is concentrated within Skagway, with the exception of approximately 15 families located slightly to the west near Dyea. Industrial land use is confined entirely to Skagway. The remainder of the city consists primarily of a watershed area to the east of the urban center.

TABLE 8.2.2-15 1964 LAND USE INVENTORY CITY OF SKAGWAY, ALASKA

Land Use	Acres	Percent of Total Area
Vacant	438	47
Water	261	2
Residential	22	2
Commercial	3	0
Industrial	8	9
Public and Semi-public	52	6
Streets	3	8
Total Area	931	100

Source: Skagway Comprehensive Plan 1964

An important land use consists of parkland at Yakutania Point adjacent to Skagway, the two areas of Klondike Gold Rush National Historical Park north of Skagway, and one unit of the Park in downtown Skagway. The Tongass National Forest occupies a large portion of the land in the project vicinity. The remaining land is primarily unappropriated federal lands, tenatively approved for state land selection.

No subsistence hunting, fishing, or gathering exists in this area. There are no designated wilderness areas or ecological preserves, and the primary natural areas within 10 miles of the proposed port and onshore storage facilities are Laughton Glacier and White Pass.

None of the proposed facilities will be located on lands reserved for natives.

Marine access to Skagway is confined to the Lynn Canal. Existing vessel traffic is shown in table 8.2.2-16. Traffic volume consists of cruise ships, freighters, barges, ore carriers, and regular passenger service provided by the Alaska State Ferry.

TABLE 8.2.2-16 EXISTING SKAGWAY HARBOR VESSEL TRAFFIC

Vessel Type	Summer Season (May-September) No. of Trips	Summer Season (May-September) No. of Movements	Winter Season (October-April) No. of Trips	Winter Season (October-April) No. of Movements
Ferries	174	348	152	304
Cruise Ships	60	120	-	-
Tour Ship	154	308	-	-
Ore Carriers	9	18	13	26
Freighters	30.5	61	42.5	85
Barges	22	44	30.5	61
Total	449.5	899	238	476
Average Traffic Density (movements/day)	5.9		2.2	
Annual Average (movements/day)		3.8		

There are four berths available at the port of Skagway. One berth is owned and used exclusively by the Alaska State Ferry and the three remaining berths are owned by White Pass and Yukon Route. Of these three berths, one is used exclusively by the railroad for its freighters; one is used by ore carriers; and one is open for all other traffic. Although no traffic congestion exists in the harbor and Lynn Canal, there is a berthing deficiency. Presently, there are nine days during the summer when there is a shortage of 11 berths for vessels. Existing piers within Skagway are shown in table 8.2.2-17.

TABLE 8.2.2-17 SKAGWAY HARBOR PIERS AND OPERATIONS

Pier Number	Operator	Principal Use
1	White Pass and Yukon Route	Cruise Ships and Barges
2	White Pass and Yukon Route	White Pass Freighters
3	White Pass and Yukon Route	Ore Carriers
4	Alaska State Ferry	Ferry

Source: NEC 1979

The present yearly capacity of ferries servicing Skagway is 164,340 passengers and 28,556 vehicles, with a peak season capacity of 103,840 passengers and 18,568 vehicles. In 1978 six cruise ships, making a total of 60 visits, brought 38,000 passengers to Skagway, while a daily summer tour ship carried 17,955 passengers.

Industrial aspects of the port traffic include ore carriers which annually transport 530,000 tons; freighters carrying 290,000 tons per year; and barges unloading at a rate of 1 million barrels per year.

The roads in Skagway form a gridiron pattern of gravel streets except for State Street which is a paved road that is part of the state highway system. Figure 8.2.2-12 illustrates the 24-hour peak season volume projections for 1979. The percentage of the existing traffic data representing tourism was factored at a rate of 11 percent. This figure accounts for an anticipated increase in traffic volume resulting from the first peak season the Skagway-Carcross highway is operational (Alaska Department of Highways 1973). Total traffic volume was then projected using the area's 2 percent growth rate (Wilbur Smith and Associates 1978).

The Skagway-Carcross highway officially opened in the fall of 1978 and is usable between April 15 and October 15. There is no snow removal during winter months. The capacity of the highway is 14,000 vehicles per day (Wilbur Smith and Associates 1978). An expected daily traffic volume of 552 during the summer of 1980 indicates the highway has excess capacity.

Skagway rail service provided by White Pass and Yukon Route includes three trains daily each way for a total of six trips on the line. One of these trains, operating only in the peak season, is the Bennett Lake round trip tour which in 1978 attracted 23,000 passengers. Another train, a mix of passengers and freight, runs between Skagway and Whitehorse; and a third is a freight train following the same route. In 1978, 25,000 passengers traveled from Skagway to Whitehorse and 23,500 made the return trip. The White Pass and Yukon Route is nearly at passenger capacity; 95 percent of all passenger trips between Skagway and Whitehorse occur during the summer peak season. The freight trains run year round and in 1978 transported 750,000 tons of freight.

Skagway airport is an uncontrolled facility; no capacity or traffic statistics are available. Since instrument landing facilities are not available, landing periods are restricted to daylight hours when the city is not fogged in. Southeast Skyways Inc. and L.A.B. Flying Service are the only airlines providing scheduled passenger service. During the peak season of May through September there are 14 flights scheduled but total operations during the peak season are estimated at 20 flights per day.

An estimated 10,000 air passengers land yearly at Skagway; 60 percent of this service is provided by Southeast Skyways Inc. Seventy-five percent of total traffic occurs during the peak season.

Skagway's only source of power is Alaska Power and Telephone Co., which provides the area with 2,170 kilowatts of power in the winter. In the summer, a small hydro system generates an additional 330 kilowatts of power. The firm power is 900 kilowatts. Alaska Power and Telephone Co. will increase power 1,250 kilowatts by January 1980. Peak demand is 1,100 kilowatts and 1,000 kilowatts during the winter and summer, respectively. Power generation of the system is expandable, but more distribution would require a new feeder.

SKAGWAY ROAD NETWORK/TRAFFIC VOLUMES for 1979

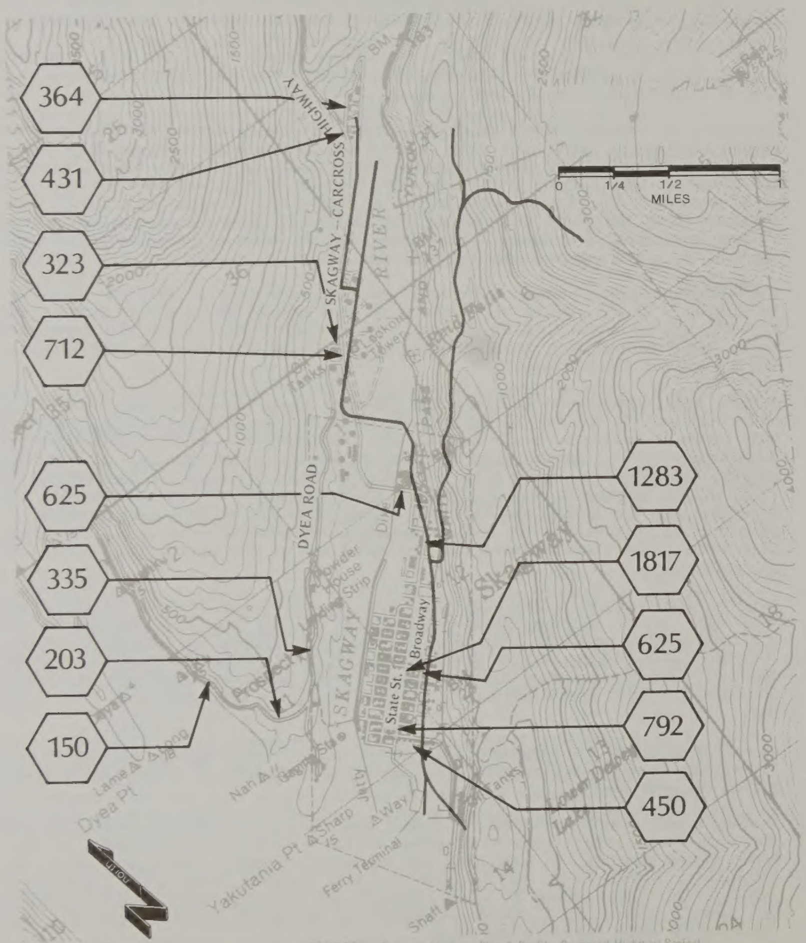


Figure 8.2.2-12

SOURCES: State of Alaska – Plan & Profile, Proposed Highway Project
Alaska D.O.T. – July 1977 Automatic Traffic Recorder Counts
Skagway to Canadian Border – Final Environmental Section 4(f) Statement

The CANOL Line, owned by White Pass and Yukon Route and following the route of the railroad, is a 12-inch buried pipeline running from the freight wharf to Second Avenue. The line parallels the airfield and then crosses the Skagway River at the Skagway River bridge and continues on to the existing storage facility. From this point the line bcomes a 4-inch pipeline that retraces its route across the bridge and then, both above and below ground, follows the White Pass and Yukon Route to the Alaska/Canada border. The pipeline carries petroleum products to Whitehorse, Yukon Territory.

RECREATION

Tourists come to SKagway to see the scenery and the sites and structures from the days of the Klondike gold rush. In 1978, the Alaska State Ferry System carried 21,048 passengers to Skagway and returned 19,149 to points southeast. (The difference can be attributed to passengers traveling overland or by plane.) Summer ferry service provides 8 trips per week to Skagway, and accounts for about 80 percent (17,000 passengers) of the annual ferry use. During the same period six cruise ships made 60 stops at Skagway and carried 37,800 passengers. A third option for visiting Skagway is a one trip per day tour boat which, like the cruise ships, operates only during the summer. The 1978 usage was 17,955.

Visits to the Haines and Skagway sites of the Alaska State Park System were 23,329 in 1973-1974, of which 80 percent were visits by non-residents (Clark and Lucas 1978).

The town of Skagway is a major tourist destination. Local information suggests that the bulk of visits to Skagway are part of a tour package, i.e., round-trip or one-way cruise package or a tour utilizing various air, road, rail, and ferry legs. Many tourists are drawn by hiking and backpacking opporunities on the Chilkoot, Gold Rush, and other trails. In addition to sightseeing in the town or riding the historic narrow gauge railway, an estimated 2,000 tourists take airplane tours over the area.

A change in the volume and character of tourism is anticipated as a result of the 1978 opening of the Skagway-Carcross highway. This highway permits Yukon residents easier access to marine recreational areas by shortening the route to fishing and boating areas from Whitehorse by 150 miles. By permitting Skagway tourists to link a car journey with the ferry system, the highway also allows for greater flexibility in tourist travel.

Skagway operates a small boat harbor with a capacity of about 75 vessels. Most recreational boating occurs during the summer. High winds necessitate the use of craft longer than 23 feet and make boating relatively difficult in the Lynn Canal near Skagway. Moorage space is usually not filled in the summer, except during September when the fishing fleet spends two weeks in the Skagway harbor. Pleasure-craft registration in Skagway shows 66 boats.

Visitors to the historic Skagway portion of the Klondike Gold Rush National Historical Park can be roughly estimated at over 100,000 annually. Molly Walsh Park, located within the historic part of Skagway, serves residents as well as tourists. The Hanausek Campground could, during a full summer season of approximately 150 days, provide capacity for over 3,000 camp stays (20 campsites) or 9,000 to 12,000 visitor days (at 3 to 4 persons per camping party). Liarsville Campground, the only other campground in Skagway, had approximately 1,000 visitors in 1973-74.

ECONOMIC CONDITIONS

Communities in the upper Lynn Canal area of southeastern Alaska are tied to Skagway as part of an economic region. The Alaska Division of Lands has analyzed the Haines-Skagway area as one land management planning area. Analysis of potential impacts in Skagway resulting from construction and operation of the proposed oil pipeline project must be based upon an understanding of the regional situation.

Haines is the largest city in the northern Lynn Canal area and the government service center, but other communities are also part of the regional economic base, particularly Hoonah and other small predominantly Native Alaskan towns. Developments occurring in Yukon Territory, Canada, have a direct bearing on employment levels and the economic well-being of Skagway. Yukon Territority must also be considered part of the potential impact region.

At the present time Haines is undergoing a period of economic stagnation. Closures of the local lumber mills due to lack of timber and a depressed market and the normal vagaries of the fishing industry have driven unemployment to a level estimated by local officials to be as high as 50 percent. The most recent Department of Labor statistics show Haines Borough with a 15.7 percent annual unemployment rate, a rate which seriously underestimates actual unemployment levels. As a result of persisting unemployment in Haines, a pool of qualified labor is available to work on major projects in the region.

Haines is the regional service center. The state trooper, the Fish and Game enforcement officer, the post secondary school educational facilities, the medical clinic and physicians, the public health nurse, and the dental clinic (presently without a dentist) are all located in Haines but also serve Skagway.

Haines has recently been sharing the expansion of the tourist industry with Skagway, though to a much lesser extent. Although both Haines and Skagway are stops on the Alaska Marine Highway, Skagway also is a terminus for cruise ships. The Jones Act limits foreign registered vessels to only four U.S. stops. On Alaska cruises the four are Ketchikan, Juneau, Sitka, and Skagway. Should Skagway have to limit the number of cruise vessels, then overflow could shift to Haines. Presently ferry passengers disembarking at Haines spend a very brief time in town and spend little money, but cruise passengers in Skagway are more affluent and spend more time.

The fishing fleet operating in and around the Haines area of upper Lynn Canal and Icy Straits comprised upwards of 300 to 400 boats in 1976 and 1977, of which two were based in Haines. The value of fisheries for southeastern Alaska, of which Haines is a major beneficiary, is discussed in section 8.2.2 Marine Resources. With the shutdown of the Schnabel Lumber Mill in Haines, the fisheries of the region are the basic resource industry.

The Yukon Territory of Canada, particularly the city of Whitehorse (population 14,600), is tied to the Haines-Skagway region. The Cyprus Anvil Mine at Faro, Yukon Territory, ships lead and zinc ore by truck to Whitehorse where it is loaded on the White Pass & Yukon Route railroad for transport to Skagway. In previous years ore from the Clinton Creek Mine and the Cassiar, British Columbia, mine was also brought by rail to the Skagway ore terminal for shipment to Japan. Now, however, the Clinton Creek Mine is closed and the Cassiar Mine trucks its ore to Stewart, British Columbia. The reduction of ore transported through Skagway has resulted in the loss of jobs. The railroad also carries passengers and piggy-back trailers on a daily basis between Skagway and Whitehorse. The new Skagway-Carcross highway provides another land link between Skagway and Whitehorse during summer.

The influx of visitors to the town creates seasonal jobs and is a boost to the local economy, diminishing somewhat the town's reliance upon the railroad and the ore shipments. Also, throughout the year Yukon residents come to Skagway for a relatively quick and inexpensive trip to another country.

Skagway also serves as the major port for material and fuel destined for the Yukon. General cargo is brought into the port and loaded onto trains for shipment to Whitehorse for redistribution throughout Yukon Territory. In addition, heating fuel and petroleum are brought to Skagway by small tankers approximately every 10 days. They are stored in the onshore storage facility on the northwest side of town and on the waterfront and then pumped via the CANOL pipeline to Whitehorse.

Skagway's economy depends upon two major industries, the White Pass and Yukon Route railroad and tourism, both of which depend to an increasing amount upon the Klondike Gold Rush National Historical Park.

The park was created by Congress on June 30, 1976, under Public Law 94-323, and is composed of four units: a Seattle Unit, a Skagway Historical Unit, a Chilkoot Trail Unit, and a White Pass Trail Unit. The Skagway Historic District is located in downtown Skagway, and is a major tourist attraction. Over 200,000 visitor days are projected for the Park in 1979 with the majority of such visitation occurring in the Skagway Historic District.

The White Pass Trail unit extends northward from the town on both sides of the White Pass and Yukon Route railroad.

The White Pass and Yukon Route has historically been the key to Skagway's economy. The city developed as the terminus of the only railroad into the resources of the Yukon Territory in Canada. The year-round operation of the ice-free port enabled goods to be transported into the Yukon and lead, zinc, and gold ore to be transported to markets in the U.S., Canada, Japan, and Russia.

TABLE 8.2.2-18

WHITE PASS & YUKON ROUTE RAILROAD EMPLOYMENT AND HAULING STATISTICS

Employees	1974	164
	1975	180
	1976	168
	1977	168
	1978	168
Passengers	1974	50,000
	1975	62,000
	1976	68,000
	1977	75,000
	1978	75,000
Tonnage	1974	739,000
	1975	787,046
	1976	544,044
	1977	736,767
	1978	734,781

Source: NEC 1979

Labor market and employment conditions in Skagway are not precisely known because published statistics group it with Yakutat and Hoonah (dissimilar cities specializing in completely different industries) as well as the villages of Elfin Cove, Gustavus, and Pelican. The most recent analysis of Skagway labor force conditions, based on unstructured interviews with officials and business people, estimated that in July 1976 unemployment was 12.5 percent of a labor force totalling 478 full time, part time, or seasonal workers. Table 8.2.2-19 is from the same study.

Seasonal fluctuations of employment earnings and unemployment are severe in the Skagway area. Total employment in the Skagway-Yakutat Division typically peaks in June, July, and August and slumps to about 70 percent of the mid-summer level in December and January. Fluctuations in Skagway are probably not as extreme because of the relative stability of the railroad work force.

Some indication of typical monthly wages in Skagway is given by Alaska Department of Labor data on major groups of insured non-agricultural industries for the Skagway-Yakutat Division and for the state in 1977 (see table 8.2.2-20). Skagway-Yakutat Division workers generally earned less than the state average in any given industry. The highest-wage sector in Skagway--transportation--also has the largest employment so that the city's average monthly wage is doubtlessly higher than the Division's.

TABLE 8.2.2-19

EMPLOYMENT BY SECTORS OF THE ECONOMY

SKAGWAY, ALASKA - JULY 1976

Sector	Self-Employed	Full-Time & Part-Time Employment	Seasonal Employment	Total
Construction1/	2	6	–	8
Manufacturing	1	–	–	1
Transportation	4	179	35	218
Communications and Public Utilities	–	6	–	6
Trade	12	30	8	50
Finance, Insurance, and Real Estate	1	6	–	7
Service	14	35	56	105
Federal Government	–	3	1	4
Local Government	–	29	–	29
State Government2/	–	2	–	2
Totals3/	34	296	100	430

Source: Economic Development Administration 1979

1/ Does not include 50-60 full and part-time workers engaged in the construction of the Skagway-Carcross highway.

2/ 10 State employees are listed within the transportation sector.

3/ A number of workers fall into more than one sector of the economy due to holding two part-time jobs, self-employed persons working part-time for others, etc. Thus, while the figures do not agree precisely with the employment totals previously given, they do give an accurate picture of the relative importance and seasonality of the various sectors of Skagway's economy.

TABLE 8.2.2-20

EMPLOYMENT AND WAGES, 1977

	Average Month By Employment		Average Monthly Wage	
	Skagway-Yakutat Division	State	Skagway-Yakutat Division	State
Nonag. Wage & Salary				
Employment	938	164,100	$1,312	$1,781
Mining	*	5,000	*	3,062
Contract Construction	*	19,500	*	3,565
Manufacturing	*	10,900	*	1,496
Transp., Comm. & Public Utilities	259	15,600	1,780	2,045
Wholesale trade	*	5,900	*	1,845
Retail trade	127	22,600	606	991
Finance, Insurance, Real Estate	9	7,800	1,214	1,283
Services	96	27,400	1,014	1,457
Fed. Government	63	17,700	1,398	1,495
State and Local Government	190	31,100	1,308	1,578
Miscellaneous	*	700	*	1,579

Sources: Alaska Department of Labor Statistical Quarterly, First Quarter 1978 and all of 1977, Alaska Dept. of Labor, Alaska Labor Force Estimated by Area (Revised 1974-1977) and Statewide (Revised 1970-1977) and Employment and Industry 1977

* Withheld to comply with disclosure regulations.

The Chevron and Alaska Ferry Terminal petroleum products storage facilities are at the port of Skagway and a White Pass & Yukon Route storage facility is located at the north end of town. The port storage facilities are composed of 16 operating tanks ranging from 464 to 25,300-barrel capacity, containing heating and diesel oil and aviation and automobile gas. The White Pass & Yukon Route storage facility has 15 10,000-barrel tanks for heating oil. Oil is delivered to Skagway in 6,000-ton tankers approximately every 10 days. Gasoline is delivered in 800,000 or 900,000-gallon barges approximately every 10 days.

Skagway has a debt limit set by city ordinance at 25 percent of assessed valuation. As of January, 1979 the assessed valuation was $39.3 million and the debt limit was $9.8 million. Outstanding debt totaled $1.1 million, leaving a borrowing capacity of $8.7 million. Tables 8.2.2-21 and 8.2.2-22 show the city's fiscal data.

TABLE 8.2.2-21 ANALYSIS OF REVENUES CITY OF SKAGWAY FY 1978-79 BUDGET 1/

	Amount	Per Capita
Property Taxes	$ 308,663	$ 434.05
Licenses and Permits	12,750	14.53
Rentals and Moorage	34,900	39.79
State Revenue Sharing	48,000	54.73
Federal Revenue Sharing	44,000	50.17
Utility Charges	150,250	171.32
Other	40,550	46.24
Total	$ 639,113	$ 728.75

Source: NEC 1979

1/ Property taxes constitute 53.5 percent of revenues in the budget. The current property tax rate is 10.5 mills.

TABLE 8.2.2-22 ANALYSIS OF EXPENDITURES CITY OF SKAGWAY FY 1978-79 BUDGET

	Amount	Per Capita
City Hall, Manager & Clerk	$ 93,805	$ 106.96
Fire Department	23,855	27.20
Police Department	87,295	99.54
Schools	54,000	61.57
Parks and Recreation	10,282	11.72
Health Center	4,500	5.13
Election, Tourism Promotion and Council	11,300	12.88
Administration	73,500	83.80
Public Works	161,925	184.63
Port Authority	37,750	43.04
Other Departments	25,465	29.04
Employer Payroll Expenses	61,000	69.55
Total	$ 644,677	$ 735.06

Source: NEC 1979

SOCIAL CONDITIONS

The 1970 U.S. Census reported Skagway's population at 708; and it was estimated to be 877 in July 1978 (Alaska Department of Community and Regional Affairs 1978). The population is not typical of southeast Alaska in terms of structure and composition. It is more homogeneous in terms of race, income, employment, and social status (U.S. Department of Labor 1976). According to the 1970 census, 93.5 percent of Skagway's residents were white, which is atypical for the region. The median age for Alaska in 1970 was 22.9 years and 25.2 years in Skagway. Over half of Skagway's population was in the working age group, 16-64 years.

Social changes in Skagway can affect Haines, approximately 15 miles south. Although there are no roads between the cities, frequent interaction is by means of ferry. The 1977 population of Haines was estimated at 1,366 by the Alaska Department of Community and Regional Affairs. The 1970 population of 683 was about 23 percent Native American, and it was 25 percent Native American in 1978.

Skagway has a scarcity of available land and currently suffers from a serious housing shortage during the summer tourist season. The vacancy rate is nearly zero, and sub-standard housing units are occupied. New homes are being constructed at the rate of 2 to 3 per year, and are priced in the $77,000 to $100,000 range. There are four apartment buildings with 4-6 units each, and two buildings with 2-4 units each. These are normally fully occupied during summer months (Skagway City Manager per. comm. 1979).

The city has five hotels with a total of 200 units. Three hotels are open year-round. Construction of an additional 50 units is planned since summer tourist demands consistently exceed available hotel accomodations. Residents also provide lodging in their homes for a small percentage of tourists. Skagway has a 20 unit campground, and the state has a 10 unit campground available for overnight use. These are not equipped with water, sewer, and electrical hookups for mobile home use. A local service station has spaces for 10 recreational camping vehicles, with water and sewer hookups (Skagway City Manager per. comm. 1979).

Demands on the water supply, sewage, and solid waste systems are currently at or exceed capacities. Leakage into the water table from distribution mains and sewers of dilapidated wood pipe and water left running in homes to prevent pipes from freezing in winter account for a large part of sewage and water problems. A newly completed secondary treatment plant is inoperative because of cold water infusion into the collectors from the water table combined with high household water use. Solid waste is disposed of by residents at a small open dump on the Dyea road.

The Skagway school system consists of one complex for grades K through 12. Total enrollment for the 1978-1979 school year was reported at 198, well below system capacity of 275 students. The current teacher/student ratio is excellent at 1:11 (NEC 1979).

Medical services are minimal. A clinic is staffed by a local nurse practitioner. A doctor from Haines visits Skagway 2 days a week and a public health nurse visits the clinic once a month. The closest dentist is in Haines. Major medical and hospital care is provided in Juneau or Whitehorse.

Skagway has three police officers, and an Alaska state trooper stationed in Haines goes to Skagway upon request. In 1978, there were 567 incidents in Skagway requiring formal police action. Statistics over the past three years show an increasing demand for police services (NEC 1979).

Fire protection is provided by a volunteer fire department of 12 fire suppression personnel and 8 emergency medical personnel. The department has 2 water tank trucks, each with 500-gallon capacity and a 35-foot ladder. Water for fighting fires is obtained from city water mains with hydrants every block in the developed areas and every two blocks in the less populated areas.

Skagway has a land area of 1.45 square miles and a population density of 605 people per square mile, low compared to other Alaskan cities. Housing conditions in the town do not seem crowded. Almost all of the homes are single family dwellings; only 3 percent are multiple family units (NEC 1979). The rugged mountains to the north provide a barrier, while the harbor and lengthy Lynn Canal to the south provide a visual character of openness to the city.

The city has a Mayor-City Council-City Manager form of government. The current comprehensive plan for the city is about 10-12 years old (Skagway City Manager per. comm. 1979). The Alaska State Department of Community and Regional Affairs has recently prepared a comprehensive plan for the Skagway-Haines area, and the State Office of Coastal Zone Management is in the process of preparing a coastal zone management plan for the area.

The indicators that have been chosen to depict the quality of life in Skagway are lifestyle, recreational opportunities, aesthetic setting, and the city as "a place to live."

The lifestyle in Skagway is relatively simple from October through May of each year. Because of the isolated location of the city and the autonomy of the small population, the residents feel a high degree of intimacy, familiarity, and integration among families in the community.

The streets are not congested during off-season, although most residents drive to and from work. Hotels, restaurants, shops, and recreational facilities in the city are within walking distance from each other. There are two food stores, two gas stations, and a variety of specialty shops. Many goods are purchased through mail order catalogs or in Juneau or Whitehorse.

Professional services in Skagway are limited, so people must go to Juneau or Whitehorse. Although many amenities that urban dwellers take for granted are not available, residents feel that the quality of life in Skagway is good.

Lifestyles in the city undergo a transformation every year from May through September. Many residents who leave during winter months return in late April and May to re-open businesses for an expected 100,000 tourists. All five hotels are opened and several closed restaurants re-open. All facilities including hotels, restaurants, transportation services, and campgrounds are filled to capacity during tourist season. Residents of Skagway look forward to this change in their lifestyle each year, because tourism is a major source for the city's continuing existence.

Year-round recreational activities which enhance the quality of life include events sponsored by the Elks, American Legion, and Eagles organizations; activities of the Fine Arts Council including musical and theatrical productions; an active bowling league; and socializing in local bars and restaurants (personal communication, Skagway City Manager, 1979). Winter recreation includes cross-country skiing and snowmobiling; summer recreation includes hiking, camping, fishing, and boating. Expanded recreational opportunities are expected with the opening of the new highway in the summer of 1979.

The physical setting of Skagway is aesthetically pleasing to the residents. Current construction along the dock area and on some buildings in town is obtrusive to residents and visitors. The state is constructing a new dock for small boats and the National Park Service is currently restoring buildings. The residents want to retain the rustic setting.

The perceived attractive aesthetic setting, varied recreational opportunities and small town, closely-knit lifestyle, make Skagway a desirable "place to live".

The attitudes and values of the working man predominate in Skagway. Income and length of residence contribute to social status in Skagway.

PIPELINE SYSTEM

CLIMATE

The climate along the 14-mile proposed pipeline route is widely varied. No meteorological data are available.

Elevations along the pipeline route are higher than Skagway, temperatures lower, and snowfall greater. Wind speed and direction are influenced by local topography. Some high wind speeds may be expected in the White Pass area from wind channeling.

AIR QUALITY

The only man-made source of any pollutant along the pipeline route is the White Pass & Yukon Route railroad. Emissions are insignificant. Ambient levels of nitrogen dioxide, sulfur dioxide, and carbon monoxide are expected to be below ambient levels in Skagway. Concentrations of ozone along the pipeline route should be approximately the same.

A major source of particulates is windblown dust. While the ambient concentrations of particulates will generally be low, there is considerable variability in concentration with location because of wind conditions and soil surface stability.

NOISE

Noise levels along the proposed pipeline route are low. Major noise sources are four to six trains per day of the White Pass & Yukon Route railroad and motor vehicles on the Skagway-Carcross highway from May to October. No measurements of noise were taken in this area, but a site inspection confirmed that this area has very low noise levels except when trains or vehicles are operating.

TOPOGRAPHY AND GEOLOGY

The proposed pipeline route largely follows the railroad from Skagway to White Pass. The railroad is constructed on a narrow cut in the rock over approximately half the route, often at the base of slopes exceeding 100 percent. The tracks climb at about a 2.7 percent grade with portions as steep as 3.9 percent. The topography alongside the tracks consists of slopes ranging in heights from 0 to 3,000 feet. The railroad passes through two tunnels and crosses numerous trestles spanning streams which drain snowfields and glaciers on high terrain to the east. The upper third of the route traverses spectacular and highly precipitous terrain. The topography of the proposed route is shown in the Map Addendum.

After leaving the onshore storage facility the pipeline would traverse the alluvial deposits and channel of the Skagway river and join the railroad at the base of steep timbered slopes. These slopes consist of rock and rock outcrops and a thin mantle of rockslide debris and glacial till with smaller amounts of alluvium. The route would continue over increasingly rocky and precipitous slopes, making numerous stream crossings, until reaching the Canadian border.

Bedrock consists of intrusive plutonic rocks such as quartz monzonite and diorite as well as metamorphic rocks such as schist, quartzite, and gneiss. Small rhylotic intrusive bodies also occur along the route.

Surface deposits consist of weathered mass wasting debris ranging from boulder to clay sizes. These deposits, together with smaller amounts of glacial till and alluvial deposits, mantle the bedrock in varying thickness.

Joints and sheeting fractures are generally well developed in the bedrock. Joints generally strike northeast-southwest and dip vertically to very steep. In some areas joints dip more horizontally. Jointing is subparallel to some of the inferred faults or lineaments along the route. Sheeting fractures are often aligned with the valley walls dividing the rock into slabs of from 3 to 5 feet thickness. Fault or shear zones, containing fractured and weathered rock products, cross the proposed alignment in several Places. At White Pass a near vertical shear zone contains slickensides indicating strike slip faulting.

Because of glaciation the bedrock has been generally swept clear of weathering products; therefore the rock is relatively sound (apart from joints and fractures). There are some fractural or faulted areas where weathering may have progressed to a depth of up to a few tens of feet, providing an accumulation of disintegrated rock material.

The pipeline route is located within a zone 3 earthquake risk area, close to the boundary of zone 4. A zone 3 area is characterized as subject to "major possible maximum damage to structures," i.e., Richter magnitudes in excess of 6.0.

Along most of the proposed pipeline route the steep, hardrock valley walls typically do not experience as severe shaking during earthquakes as that which occurs on thicker surficial deposits such as those underlying Skagway. In times of earthquakes, induced accelerations in the rock are inferred to be greater than 0.1g and higher accelerations probably occur in the river alluvium at the East Fork and the White Pass Fork junction with the Skagway River. The alluvium along the river north of Skagway may be subject to even greater accelerations. Under these conditions only minor differential settlement occurs in alluvium, at the north end of Skagway.

Elsewhere, farther upstream, conditions do not appear conducive to differential settlement.

Liquefaction is considered to be a significant factor only at and near the delta front in Skagway.

Abundant evidence of rockslides, mudflows, landslides, and avalanches is seen along the upper third of the proposed route. In recent years a mudflow crossed the railroad right-of-way at Glacier (on the Warm Pass Fork), severely disrupting the tracks. Snowslides are a frequent occurrence along the railroad in the spring. During spring snowmelt, the roadbed becomes saturated in many locations, providing the conditions for slump in the event of severe ground shaking.

Failure of steep rock slopes and cuts such as those existing in the area occur during earthquakes. These rockfalls occur primarily as sliding of rock blocks and slabs along existing joints and other fractures.

Small rockfalls caused by freeze-thaw cycles and water action occur, and are expected to continue to occur, along the steep slopes of the Skagway River north of town. As in the past, these are expected to be in the form of limited sheeting and slabbing failures along joints and other fractures. Rockslides have occurred very recently in the vicinity of the railroad switchyard, but appear to be of minor significance.

Avalanche chutes developed on the timbered slopes of the southside of Warm Pass Valley illustrate the occurrence of snowslides during spring snowmelt. Snowslides and rockslides are a continual springtime maintenance problem on the railroad north of Warm Pass Valley.

A snout of the large Denver Glacier debouches into a tributary of the East Fork of the Skagway River. The present terminus lies approximately 1.3 miles south of the East Fork, and it might reasonably be expected that at some time this snout may surge.

There are no known ore mineral resources of commercial value within the right-of-way route of the proposed pipeline. Two separate prospects of uranium and molybdenum have been reported nearby in the lower reaches of the valley. There are abandoned mine workings of the Inspiration Point Mining Company--a copper, lead, gold, and silver deposit--across the canyon near the Canadian border. Also, it is rumored that aluminum deposits have been explored on AB Mountain, and that some placer gold is recovered from Skagway River gravels. The river gravels and sand constitute an existing and future mineral resource for new construction in and near Skagway.

SOILS

Lithosols predominate along the pipeline route and occur mostly on steep slopes. Exposed rock surface with no soil cover is common.

Where the pipeline system would cross valleys, it would encounter alluvium, the other predominant soil found in the area. Total extent is about 2 miles. The alluvium is both old (thus subjected to weathering) and recently deposited. Generally, this material is moderately permeable and has good internal drainage. Due to the highly variable nature of alluvial soils and the absence of soil surveys, little is known of the exact properties of the soils along the route. Slope gradients in alluvium vary along the pipeline from nearly level to gently sloping.

AQUATIC RESOURCES

Physical Components

Detailed information for the Skagway River and its tributaries is not available. Along the pipeline route the river gradients are generally 50 feet per mile and greater. Streambed composition is likely to consist of mostly cobble-sized material and larger. Water quality of the Skagway River and its tributaries is considered to be generally high. Skagway River discharge and water quality data are presented in tables 8.2.2-11 and 8.2.2-12.

Ground water information along the pipeline route is not available, however, ground water quality is considered to be generally high.

Biological Components

Fisheries resources along the pipeline route include chum and coho salmon, Dolly Varden trout, and possibly steelhead and cutthroat trout. Freshwater life history phases are presented in figure 8.2.2-7. Specific spawning sites for these species have not been identified. A barrier falls which may block upstream migration of these species has been reported between river mile 4 and 6 (between pipeline mile 2 and 4). No fish have been reported for Skagway river tributaries above this area.

Aquatic insects throughout the area include mayflies, damselflies, dragonflies, stoneflies, and caddisflies. These insects serve as food items for juvenile salmon and trout.

MARINE RESOURCES

No portion of the pipeline crosses a marine environment; however, the pipeline would parallel the Skagway River which flows into Lynn Canal.

TERRESTRIAL VEGETATION

The vegetation along the initial segment of proposed pipeline route from the onshore storage facility to White Pass is predominantly western hemlock-Sitka spruce forest. Riparian forest and shrub thickets are found along the river bottom. Shrub thickets are also found on avalanche chutes and in the transition zone. The transition zone is between the western hemlock-Sitka spruce forests and alpine tundra (commonly-termed the subalpine zone) and begins at about 2,000 feet elevation. The subalpine zone grades into alpine tundra at about 2,500 feet. Sparsely vegetated rock is found in the alpine tundra.

Western hemlock-Sitka spruce forests cover the steep slopes of the Skagway river valley; this forest is very similar to that found along the Lynn Canal. Strips of shrubland vegetation are found on avalanche chutes and in other disturbed sites that occur throughout the western hemlock-Sitka spruce forests. Alder is the most important species in these successional areas. Other pioneer species found in these disturbed areas include fireweed, goats beard, crowberry, Pacific red alder, and stink currant (Meehan 1974; Harris and Farr 1974).

From pipeline mile 2.8 to 8.7, the pipeline would pass through a mosaic of western hemlock-Sitka spruce forest, and shrub thickets on avalanche chutes and other disturbed sites.

The western hemlock-Sitka spruce forest grades into the subalpine zone at an elevation of about 2,000 feet. The trees in this transition zone are stunted due to adverse growing conditions. Mountain hemlock and lodgepole pine are the most common species at treeline (Hutchinson pers, comm. 1979). Blueberry and Sitka alder thickets are found above treeline and in alpine meadows.

From pipeline mile 8.7 to mile 9.0 the proposed pipeline would traverse the subalpine zone.

Alpine tundra is found above the subalpine zone at an elevation of about 2,500 feet. Heathers, including crowberry, Aleutian and Mertens mountain heather, and shrubs including blueberry and arctic willow, are found in the lower alpine zone.

The pipeline would pass through alpine areas from about pipeline mile 9.0 to White Pass at pipeline mile 14.

No known endangered or threatened species exist along the proposed pipeline route.

TERRESTRIAL WILDLIFE

The route of the pipeline to White Pass would traverse three wildlife habitats. They are riparian (pipeline mile 0 to 2.8)., western hemlock-Sitka spruce (pipeline mile 2.8 to 10.0) and alpine (pipeline mile 10.0 to 14.0). Wildlife species found in the Skagway River valley generally utilize more than one of these seasonally, in conjunction with foraging or reproductive activities (see table 8.2.2-23).

A degree of habitat alteration and wildlife displacement has occurred in conjunction with past disturbances through the operation of the White Pass & Yukon Route railroad and construction of the Skagway-Carcross highway. To what extent wildlife have been affected is unknown and it is assumed that some wildlife still utilize available habitats and resources. Population densities are probably lower than in less disturbed environments.

Species using habitats along the proposed route include mountain goat, black bear, moose, wolf, coyote, pine marten, red fox, mink, marmot, lynx, otter, wolverine, and brown bear.

Historically mountain goat and black bear have been present in the greatest numbers. Mountain goats concentrate at lower elevations in the Skagway River valley during winter months and are hunted extensively by residents.

TABLE 8.2.2-23 MAJOR WILDLIFE SPECIES AND HABITATS
PIPELINE SYSTEM

Habitat Type	Vegetation	Mammals	Birds
Riparian	Riparian vegetation dominated by black cottonwood with some willow and alder species	Coyotes, red fox, moose, wolves, lynx, mink, snowshoe hare, voles, and shrews	Ruffed grouse, waterfowl, shore birds, willow ptarmigan and several passerine species
Western hemlock/ Sitka spruce Coastal forest	Coniferous forest dominated by western hemlock and Sitka spruce with some subalpine fir	Mountain goat, black bear, brown bear, pine marten, red squirrel, voles, shrews, wolverine, and lynx	Blue grouse, rock ptarmigan, great horned owl, and several passerine species
Alpine	Mountain & aleutian heather, arctic willow, blueberry, cranberry, and mat-forming herbs	Mountain goat, hoary marmot, black bear, brown bear, wolverine, wolves, red fox, and coyote	White-tailed, rock and willow ptarmigan, and several passerine species

Source: NEC 1979

Some black bear are hunted along the railroad grade in the spring. A small resident population of moose reside in the upper Skagway River bottom and several moose originating in British Columbia have been observed using the recently opened highway corridor. Brown bear, wolves, wolverines, and lynx are seen occasionally.

Lynx, coyote, wolverine, and red fox use a variety of habitats along the pipeline corridor. They feed primarily on small mammals such as snowshoe hare, birds, and carrion. Coyote, red fox, and wolverines also consume berries and invertebrates. Their population densities are relatively low.

Bald eagles generally are present only during salmon runs on the Skagway river, as they prefer open coastline areas for nesting and other foraging activities. The great horned owl inhabits western hemlock-Sitka spruce forest along the proposed pipeline route.

The upland game birds found along the pipeline corridor include ptarmigan and grouse. The ptarmigan is represented by three different species: willow, rock, and white-tailed. The willow ptarmigan is the most widely distributed. The rock ptarmigan ranges above timberline along the pipeline route and somewhat adjoins that of the willow ptarmigan, but generally it occurs at drier and rockier sites at higher elevations. White-tailed ptarmigan inhabit rugged, sparsely-vegetated areas above timberline.

Blue grouse inhabit forests of western hemlock and Sitka spruce, while ruffed grouse inhabit deciduous woodlands interspersed with spruce, on relatively dry, well-drained, south-facing slopes.

Distribution of water fowl and shorebirds along the pipeline corridor is limited to the Skagway river. No nesting or molting areas have been identified within or adjacent to the Skagway River, indicating utilization primarily occurs during spring and fall migration periods.

The area also contains the northernmost breeding habitat of the rufous hummingbird. There are no rare and endangered terrestrial animals.

CULTURAL RESOURCES

By 1897 a wagon road extending from the beach 4 miles along what is now Broadway Street had been cut to White Pass City (see figures 8.2.2-9, 8.2.2-10, 8.2.2-13 and 8.2.2-14). The Royal Canadian Mounted Police set up a customs post at the summit. This not only established the border but also served as the nucleus of a small settlement.

In 1897 the Skagway and Yukon Transportation and Improvement Company formed and began construction of the Brackett Wagon Road through White Pass to Bennett Lake (see figures 8.2.2-9, 8.2.2-10, 8.2.2-13 and 8.2.2-14).

In 1898 the White Pass & Yukon Railroad (later known as White Pass & Yukon Route) was organized and the first construction begun. The original railway tracks also went up Broadway Street in Skagway. The White Pass & Yukon Route railroad yard and its associated buildings would be considered an important historical site.

From milepost 5 to the summit of White Pass (see figures 8.2.2-13 and 8.2.2-14), the original railroad bed followed essentially the route of the Brackett Wagon Road. When the lower section of the railroad on the eastern bank of the Skagway river was constructed in the 1930s the last stretch of the Brackett Wagon Road between Skagway and mile 5 was covered.

The White Pass & Yukon Route railroad track above mile 5 follows the original route established before 1900. It, therefore, is eligible for consideration as a National Historic Landmark. Most of the camps and stopovers used by passengers near the turn of the century are likewise eligible for nomination if any vestige of the past survives.

White Pass City is a site of major importance on the trail. An 1897 photograph of the time shows only some tents in the thicket, but an 1898 photograph shows at least seven log cabins and one frame building. The ruins of a number of buildings were still visible in 1969.

The trail ascends "Dead Horse Gulch" above White Pass City. It is in this area that some 3,000 pack animals died in 1897 to 1898. As of 1969, the bones of many pack animals were still visible; some abandoned gear was also observed.

Summit was a camp located at the summit of White Pass. At first this was little more than a tent camp; then the Canadian government established a customs post in 1898. People going over the pass had to stop and pay duty. This legal bottleneck created a

LOWER SKAGWAY RIVER VALLEY
MILE 5-9.5 W.P. and Y.R.

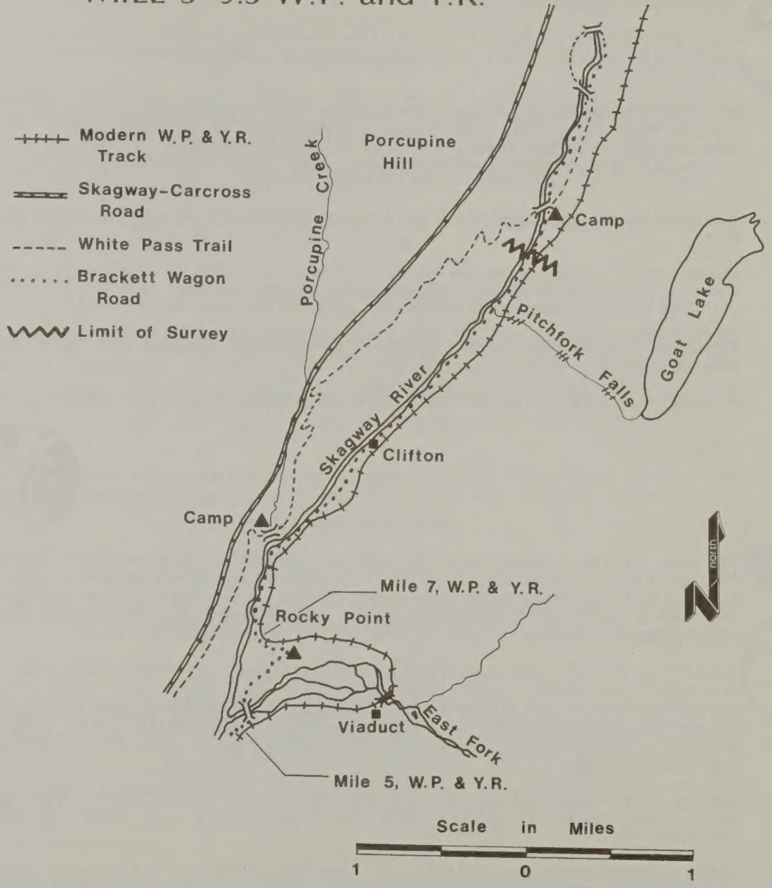


Figure 8.2.2-13

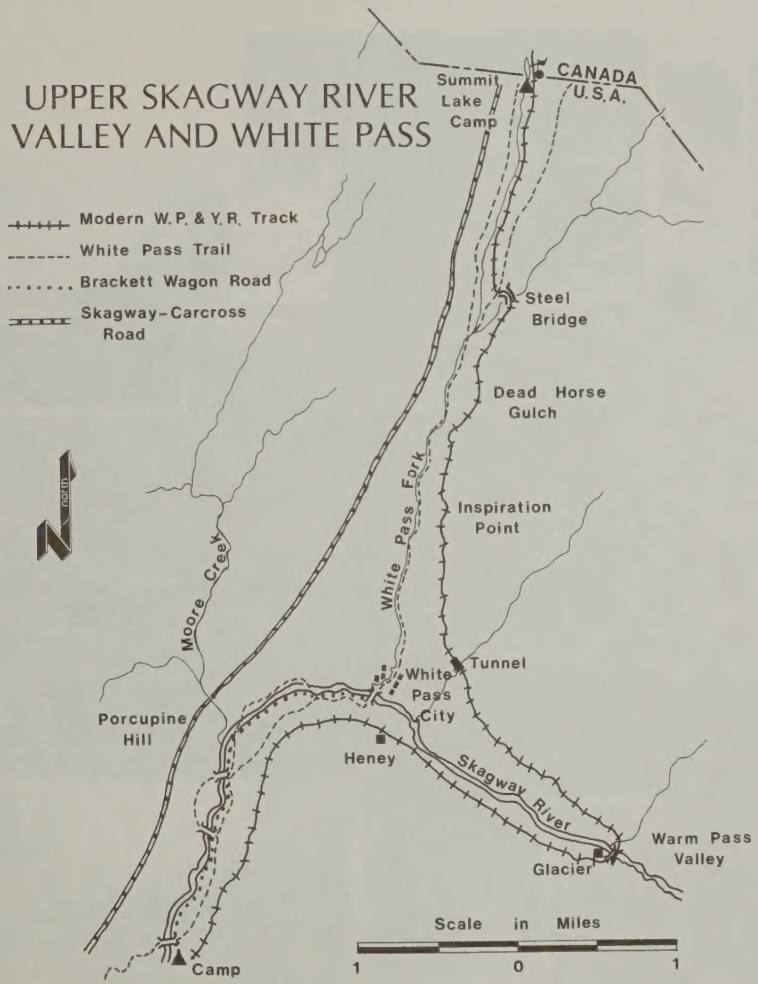


Figure 8.2.2-14

large tent city at the summit. Later, when the railroad came through, the settlement became more permanent.

Many areas of historic interest exist along the railway above mile 9. North along the tracks is Black Cross Rock which marks the grave of two men. Construction camp 5 is located where the tracks begin to swing wide, up the Skagway river. The remains of this settlement and the cable system might be visible. Where the tracks cross the Skagway river is a telegraph station called Glacier, a National Historic Landmark.

Swinging back along the north side of the Skagway river and starting up White Pass Canyon, the railroad approaches Tunnel Mountain. There are old photographs of a trestle leading to a tunnel cut through the mountain at this point.

Shortly after leaving Tunnel Mountain, the railroad reaches Inspiration Point. There was a telegraph station here and a mine was located on the hillside opposite the tracks. There is a steel bridge which was finished in 1901. At this point there appears to have been a small railroad yard, since a 1904 photograph shows a roundhouse on the site. The original roadbed, before the bridge was finished, went up this side of the canyon in an acute switchback. This switchback should still be visible.

The railroad station of Glacier is reported on the Alaska Heritage Resources Survey. Creation of the White Pass Historic District in 1962 added the White Pass Trail, the Brackett Wagon Road, and the White Pass & Yukon Route railroad line. Camps and stop-over points along these trails are also included as part of the historic properties of the district. Further planning by the National Park Service includes the White Pass area as part of the proposed Klondike Gold Rush National Historical Park.

No prehistoric archeological sites or fossil localities have been reported.

VISUAL RESOURCES

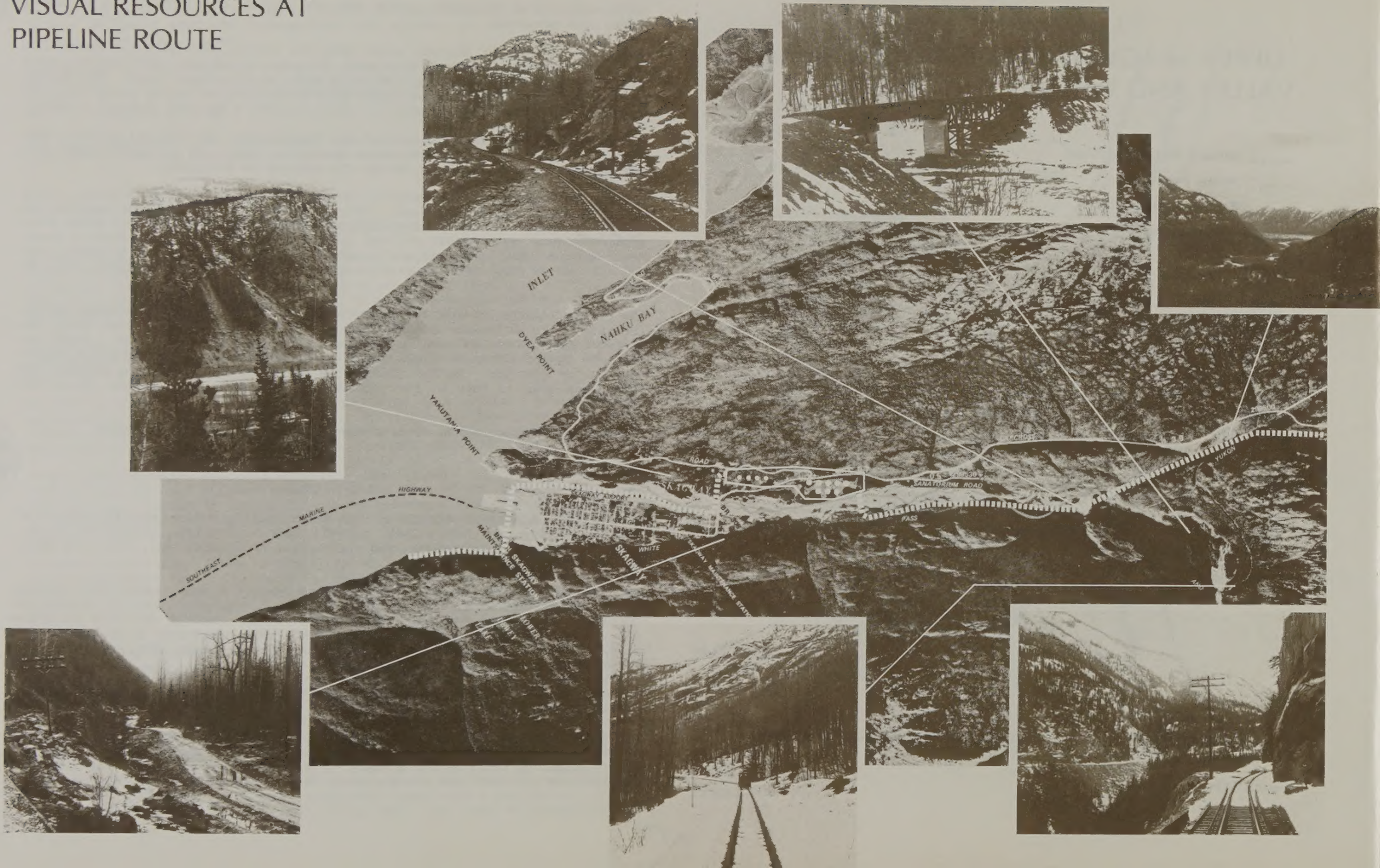
Most of the route has a moderate to high scenic quality and is rated A/B because of the considerable land form relief, colorful rock outcroppings, mosaics of forest, woodland, or brush color interspersed with meadows or pastoral land, rivers and other prominent features.

The land and bedrock from Skagway to White Pass is a high relief with steeply sloping mountainsides and narrow valley bottoms. Vegetation cover is sparse; it includes a mixture of evergreens and deciduous trees. Much of the route is barren and treeless due to high elevations and rock slides; timberline is at about 2,500 feet, at pipeline mile 9. Major water features are the Skagway River and its tributaries including Pitchfork Falls.

Proposed stream crossings are visually sensitive and have particularly high scenic quality (A/B).

The pipeline route would traverse an area of high visual sensitivity, most of which is within the foreground-middleground visual zone of the Skagway-Carcross highway and the railroad. It would be near a number of proposed hiking trails and passes through the Klondike Gold Rush National Historical Park (see photographs of pipeline route).

VISUAL RESOURCES AT PIPELINE ROUTE



SKAGWAY
ROAD
SKAGWAY
RAILROAD
PASS
WHITE
BRITISH COLUMBIA
PITCHFORK FALLS
GOAT LAKE
GOAT LAKE

LAND USE

Land along the proposed pipeline route consists primarily of steep, rocky, forested land. At high elevations, further from the pipeline route, the land becomes steeper and loses its forest cover. Virtually no urban, agriculture, or rangeland/open space land uses are encountered.

There are two small native claim areas west of Skagway within 2 miles of the proposed pipeline. In addition, there is a small native claim area at pipeline mile 3.5 in close proximity to the proposed pipeline.

Important land uses within the pipeline corridor include the Tongass National Forest on the east side and the Klondike Gold Rush National Historical Park on both sides of the route in the northern section. However, there are no hunting and fishing resort developments within the corridor.

The Klondike Gold Rush National Historical Park was established in 1976 by Public Law 94-323. The Act provides that "the Secretary is authorized to grant rights-of-way, easements, permits, and other benefits in, through, and upon all lands acquired for the White Pass Trail unit for pipeline purposes, pursuant to the Acts of February 25, 1920 (41 Stat. 449), August 21, 1935 (49 Stat. 678), and August 12, 1953 (67 Stat. 557), and for railroad purposes pursuant to the Act of May 14, 1898 (30 Stat. 409) Provided, that significant adverse impacts to park resources will not result."

According to the master plan for the Klondike Gold Rush National Historical Park, (1976), portions of the White Pass Trail and Brackett wagon road are proposed for restoration; interpretive devices would be installed along both, as well as at the site of White Pass City. The master plan lists other objectives for the White Pass trail unit such as provisions for scenic protection within the Skagway valley by cooperative agreement, protection of the ruins at White Pass City, and cooperation with officials of the White Pass and Yukon Route in preserving and interpreting the historical qualities of their railroad properties.

TRANSPORTATION AND UTILITY NETWORKS

The proposed pipeline crosses Skagway River, East Fork, Pitchfork Falls, White Pass Tributary, and White Pass Fork. It generally parallels the White Pass & Yukon Route railroad right-of-way, except for the two long switchbacks which the railroad traverses along watercourses. The existing CANOL pipeline also follows the railroad corridor.

RECREATION

Recreation along the pipeline resources is linked to the tourist oriented recreation of the Inside Passage and Skagway, discussed above in section 8.2.2 Recreation, Port and Onshore Storage Facility. Table 8.2.2-24 identifies these recreation resources.

TABLE 8.2.2-24 RECREATION RESOURCES IN SKAGWAY AND ALONG PIPELINE CORRIDOR

White Pass Trail Brackett Road Atlin-Warmpass Trail	Gold rush trails in Klondike Gold Rush National Historical Park and extending to lands outside; eligible for National trails system.
Skyline (AB Mt. Trail)	Leads from foot of AB Mountain.
Dewey Lakes Trails	Lead to fishing lakes.
Liarsville Campground	State campground (7 units); west of Skagway River at mile 2.4 of Skagway-Carcross Highway.
Hanousek Park Campground	In Skagway; city campground.
Skagway and White Pass Units of Klondike Gold Rush National Historical Park	Includes historic buildings in Skagway, trails and various sites in railroad corridor.
Gold Rush Graveyard	Graves of goldseekers who died on the trail, east of Skagway River on outskirts of Skagway.
Reid Falls	Near Gold Rush Graveyard.
Pitchfork Falls	Described by Milepost as one of the most spectacular waterfalls in Alaska.
Black Cross Rock	Cross marks burial spot of two men killed during railroad blasting.
Glacier	Railroad stop and telegraph station; classed by Curtes (1978) as a historic site.
White Pass City	Abandoned gold rush city; relics remain.
Tunnel Mountain	1,000 feet above gorge.
Inspiration Point	Panorama of mountains, glaciers and Skagway; Monument to packhorses of gold rush.
Dead Horse Gulch	3,000 pack animals died during gold rush.
White Pass Summit	Summit and international boundary; mile 14 of railroad.

Source: NEC 1979

The White Pass unit of the Klondike Gold Rush National Historical Park consists of 3,360 acres, and extends north from the Warmpass river vicinity to the Canadian border along the Skagway river. Approximately one mile in width, it includes the remnants of the White Pass Trail of 1898, Brackett Road (a log, toll road), and the Atlin-Warmpass Trail. The historic White Pass & Yukon Route railroad also traverses this section of the park. This unit contains a special use zone to accommodate a utility right-of-way, and allows for future additions to the utility corridor.

Several trails of historic interest are found in the Skagway valley. Several of these may be considered for national status.

The narrow gauge (36-inch) railroad attracts many tourists for its scenic and historic qualities, the link it provides to the Yukon for further sightseeing, and its appeal to railroad buffs. Constructed between 1898 and 1900, it helped to open up the gold riches of the Klondike by transporting men and supplies. Prior to opening the new highway, the railroad provided the only ground surface access from Skagway to the Alaska highway.

The Skagway-Carcross highway is considered a beautiful and scenic drive. It provides turnoffs for views of gorges, mountains, waterfalls, and other spectacular scenery.

Sport fishing in area streams or lakes has not been identified as a significant recreational resource at the present time. Evaluation of most areas appears to be required before sport angling potential is understood (Alaska Department of Fish and Game 1978b)

Animals hunted within the pipeline corridor are goat, small game, and brown and black bear. Hunting is relatively limited and is not considered a major attraction of the area. Lands on the west side of the White Pass & Yukon Route railroad are closed to goat hunting. The Warmpass Glacier vicinity and the lands bordering the East Fork of the Skagway river are considered good for goat hunting.

Bear hunting in the Haines-Skagway game management unit is not a major activity. In 1976, the sport harvest was two black bears and eight brown bears, taken principally by residents during the September to June season.

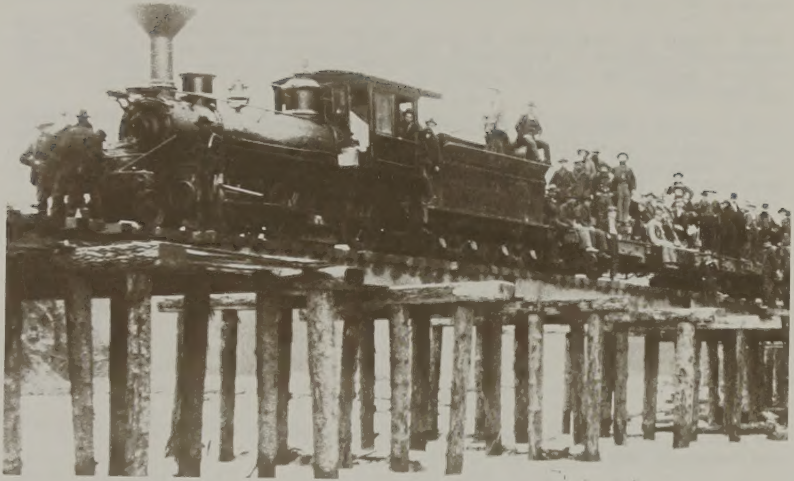
ECONOMIC CONDITIONS

The economic conditions for the pipeline were combined with Economic Conditions, Port and Onshore Storage Facilities.

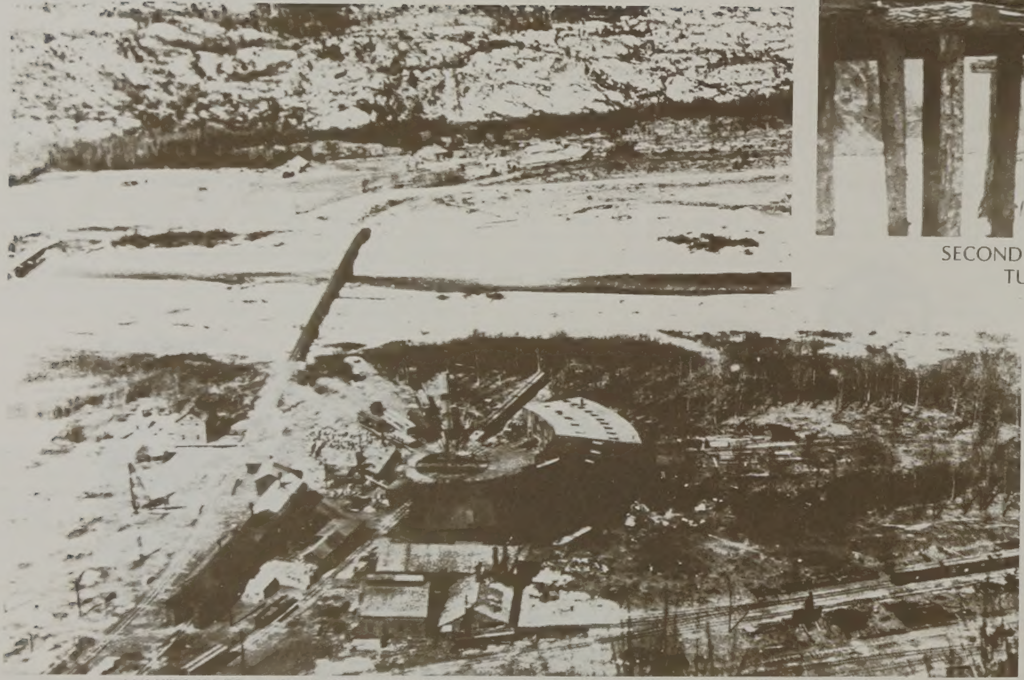
SOCIAL CONDITIONS

The social environment related to the pipeline system would be inextricably interwoven with that of the port and onshore storage facilities. Pipeline system related social considerations are discussed in Social Conditions, Port and Onshore Storage Facilities.

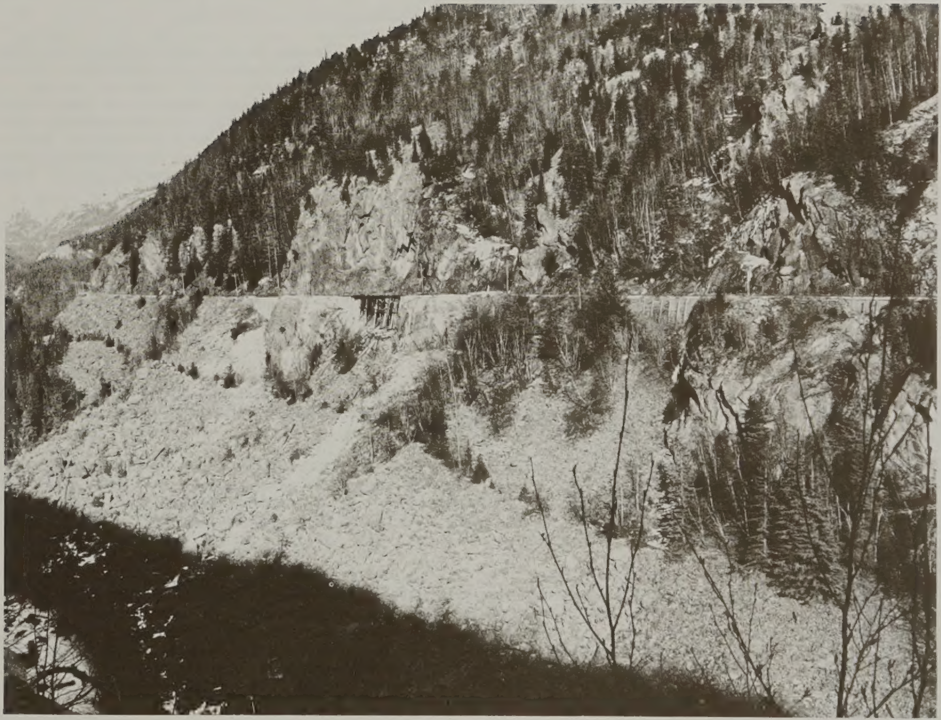
Haines, Alaska



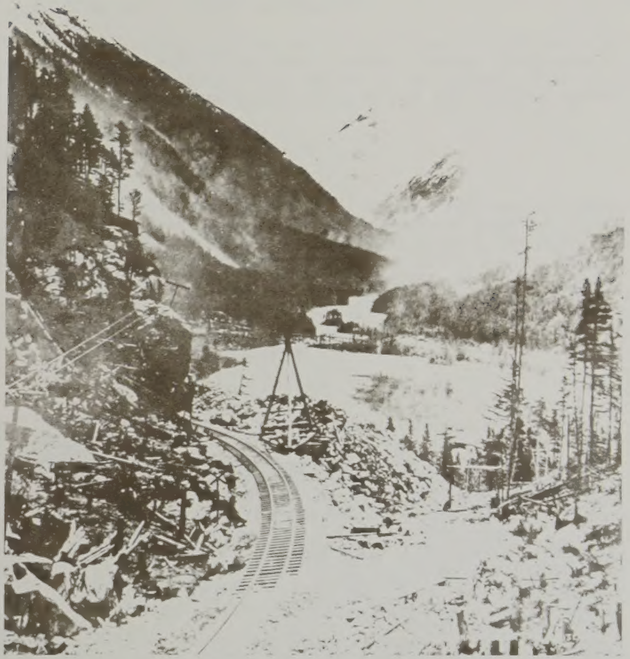
SECOND RAILROAD BRIDGE TO CROSS SKAGWAY RIVER, 1898, NEAR TUBERCULOSIS SANITARIUM (DEDMAN'S PHOTO SHOP)



WHITE PASS AND YUKON ROUTE RAILROAD YARD AND OLD RAILROAD TRACK ACROSS SKAGWAY RIVER, CIRCA EARLY 1900'S (DEDMAN'S PHOTO SHOP)



BRACKETT WAGON ROAD MARKED BY CONIFERS BELOW WHITE PASS AND YUKON ROUTE RAILROAD TRACK (R.E. ACKERMAN)



MILE 7 ON WHITE PASS AND YUKON ROUTE, INTERESECTION OF BRACKETT WAGON ROAD, CIRCA EARLY 1900'S

(DEDMAN'S PHOTO SHOP)

8.2.3 ENVIRONMENTAL IMPACTS OF THE PROPOSAL

This section is concerned with the various impacts of the NEC proposed crude oil transshipment system. Overall, construction impacts are considered not to be too significant because of the relatively small land area involved (approximately 250 acres), and the fact that annually Skagway handles large numbers of tourists.

SEA LEG

From the time oil tankers leave the high seas at Point Ommaney, they must sail about 200 miles through Chatham Strait, Lynn Canal, Chilkoot Inlet, and Taiya Inlet to reach the proposed port and onshore storage facilities at Skagway. This long, narrow passage is of limited accessibility except by boat, and is rich in natural resources. It is considered separately from the port and onshore storage facilities and pipeline.

MARINE RESOURCES

Physical Components

The physical components impacted would be shoreline habitats. The total intertidal area endangered by a large spill could be considerable. The substrates would include mudflats, sandflats, eelgrass beds, sand beaches, gravel beaches, cobble beaches, and rocky headlands. These habitats support a wide variety of marine life, all would be equally threatened by an oil spill. Some, such as rocky headlands, could recover more rapidly than others due to differences in currents and waves.

Some oil in the spill would tend to evaporate or dissolve into the water. The rate of this evaporation and solution is affected by the degree of spreading or dispersion, formations of the oil-in-water, and atmospheric conditions. This process could spread a pollutant to the deeper waters of the channel.

Oxidation, together with biological degradation, would contribute to removal of very thin oil slicks. However, processes of biological degradation in the sub-surface water would consume oxygen content of the impacted waters, but only temporarily.

Subtidal portions of the inland waterways would be susceptible to oil pollution. Denser fractions of spilled oil may sink and affect organisms that live below the surface or on the bottom. Due to the entrance sill at the south end of Taiya Inlet, oil or other pollutants that sink below the level of the entrance sill would remain within deeper water or sediments for a considerable time. The entrance sill acts to trap the denser water in Taiya Inlet.

In sediments, the petroleum could spread out laterally; biological processes could incorporate the petroleum into sub-surface sediments. Little is known about rates of sedimentation or rates of degradation of oil in sediments.

Currents, tides, and winds are the agents that control where an oil spill will go. The rise and fall of the tide distribute the oil over a wide intertidal band along the coast. Waves mix the spilled oil into the water column limiting the efforts of containment and recovery. This region is very inaccessible from the land, a fact that would complicate clean-up efforts.

Biological Components

A potential impact which could result from shipping traffic through the Chatham Strait--Lynn Canal area is the loss of major fish, wildlife, and habitat resources due to oil spills or leaks. Operation of ships and barges could interfere with commercial fishing operations and could disrupt migratory routes and habitat utilization of a number of species. However, the increase in shipping related to construction will not augment current shipping to any large degree.

The low frequency of large vessel traffic in Chatham Strait and Lynn Canal area has not produced significant loss of fishing gear or interference with commercial fishing activities (ADF&G 1979). However, major problems could result from an increase in large vessel traffic in southeastern Alaska (ADF&G 1978). Because of the limited maneuverability of tankers, long line fishing gear, gillnets, and purse seines, would be susceptible to entanglement and loss. If tanker corridors or one-way traffic patterns were established, they would reduce the available area for fishing. Since vessels using gillnets are sometimes drifting, a traffic separation system would not be adequate to preclude collision.

Increased tanker traffic in Chatham Strait and Lynn Canal may disrupt or disturb the migratory patterns and habitats utilized by marine mammals. The humpback whale may be particularly sensitive to noise from large vessels (ADF&G, 1979). Vessel traffic in Chatham Strait may impede the migration of whales into Frederick Sound and Stephens Passage. Both areas are frequented by the endangered humpback whale. Sea lions, sea otters, harbor seals, and many birds that are sensitive to disturbance (ADF&G 1979). It is not known if tanker traffic would cause a significant level of disturbance to these species.

Tanker traffic may increase the level of dissolved hydrocarbons in the water along the route due to chronic release of oil. The increase would tend to be localized and the overall impact would be moderate.

In the case of an oil spill, trajectories indicate that oil would reach a shoreline usually within 12 hours after release; the spill would tend to move along the coast and into the bays and inlets in the area. It is doubtful that oil spill containment and cleanup equipment could be mobilized in time to prevent the spill from impacting the coastline. A possible exception would be if a spill occurred near Skagway.

Based on statistics from 1973-1976, the average spill size for tankers in transit for eight major port systems was 864 barrels. Using the same data base, the average spill size for tankers at berth was 122 barrels.

The above data were used to develop the basic assumptions for the following analysis of specific area impacts. These assumptions are:

a spill greater than 860 barrels would occur;

the time for oil to reach shore would be less than 12 hours; and

oil spill containment and cleanup equipment would not be used.

Six areas were arbitrarily selected by NEC but they represent the various habitats along the tanker route.

Cape Ommaney

An oil spill near Cape Ommaney would have a major impact on sea lion haul-out areas on the Cape. The spill could adversely affect the sea lion colony on Hazy Islands, 15 miles south. The spill would have major impacts on tanner and king crab and salmon fisheries near the Cape. Halibut, lingcod, and rockfish fisheries would suffer moderate to minor impacts.

The spill could spread along the outer coast severely impacting bird colonies at Guilbert Islet and Biali Rocks. Anadromous streams located along the coast could be affected. The degree of impact would depend on how far inland the oil penetrated. Effects of the spill on whales is uncertain due to the lack of information.

The rocky outer coast would recover quickly. However, oil trapped within bays and inlets would tend to persist; recovery of the area is estimated from 5 to 10 years.

Baranof Island

A spill occurring near Baranof Island would move along the coast. The spill would have major impacts on migratory bird habitats. If the spill moved north, Kasnykeu and Kelp Bays which are critical habitat for herring and migratory birds could be affected. Both resources would suffer major impacts. The spill would probably severely limit or curtail operations of the Hidden Falls Hatchery on Kasnykeu Bay. Habitat recovery in bays and inlets would be extremely slow.

Hanus Reef

Spill trajectories indicate that a spill at Hanus Reef would move south along the shore of Chichagof Island into Freshwater Bay and Tenakee Inlet during the winter. During summer, the spill would move north along the western shore of Mansfield Peninsula. Spills reaching Freshwater Bay and Tenakee Inlet would have major impacts on herring, salmon, and Dungeness, king, and tanner crab fisheries in the area. The Bay and Inlet are also critical habitat for harbor seals and migratory bird populations both of which would be severely impacted. Mansfield Peninsula is a prime nesting habitat for bald eagles. Spills along the coast could adversely affect their food supply. Recovery of habitats in the protected bays and inlets would be slow, requiring a minimum of 5 to 10 years.

Berners Bay

Berners Bay has been identified as critical habitat for shore birds, migratory birds, herring, and salmon. Echo Cove in Berners Bay is one of only two areas where crab larvae have been observed to concentrate. Impacts to these resources would be critical. A major sea lion haul-out area is located just south of the Bay; these mammals could suffer major impacts. Recovery from an oil spill in the Bay would be slow, requiring a minimum of five to ten years.

Katzehin River

The narrowest point of the proposed tanker route is at the mouth of the Katzehin River. A large tanker grounding here could effectively close the entrance to Taiya

Seal pups in typical concentration of late summer

U.S. Fish and Wildlife Service

Inlet and Skagway. Spill trajectories indicate that within 24 hours, spilled oil could move almost to St. James Bay in the winter, and almost to Skagway in the summer.

The river delta is a prime habitat for shore and migratory birds, which would suffer major impacts. This area is intensively fished for salmon, which also would suffer major impacts. This large intertidal area (20 foot tidal range) would be severely affected by an oil spill, reducing the zone's productivity.

Skagway Harbor

Oil spills in Skagway Harbor in the summer months could be contained or cleaned up. Oil spills in the harbor would have moderate to minor impacts upon marine resources, except salmon. Spills in the harbor could disrupt the migration of salmon up the Taiya and Skagway Rivers. Oil spills that moved down Taiya Inlet could severely impact the marine resources of Chilkoot and upper Lynn Canal. Resource impacts would be similar to those discussed concerning the Katzehin river.

Commercial Harvesting

A large oil spill could reduce or curtail commercial harvesting of marine resources in an area. The extent of the impacts would vary, depending on amount spilled and the oceanographic conditions during the spill. A spill would probably not curtail all commercial fishing operations within a fisheries management district. However, as a worst case analysis, a spill is assumed to eliminate all commercial fishing operations in a district for one year. The other assumptions are :

- the spill impacts the Lynn Canal District;
- recovery will take 10 years, with 10 percent recovery per year; and
- value of the resources remains constant.

The value of resources is based on 1977 and 1978 prices. Commercial loss to fishermen in the first year would be approximately $3.7 million. Loss to local processing facilities would approach $9.6 million. Five years after the spill, the total loss to fishermen would be $14.7 million and to local processing facilities $38.1 million. Ten years after the spill, the total loss would be $20.2 million to fishermen and $52.2 million to processing facilities.

The assumptions used in calculating the economic loss are simplifications, but they clearly show the possible devastating effects of an oil spill on the southeastern Alaska region.

Impacts on the marine resources when the project is abandoned are expected to be minimal.

TERRESTRIAL VEGETATION

Tanker spills would result in damage to shoreline vegetation along Chatham Strait, Lynn Canal, and Taiya Inlet. The severity of impacts would depend on the amount of oil which reached the coast and the nature of the vegetation. Large oil spills could cause the loss of vegetation, resulting in the loss of wildlife habitat.

Effects of oil on the vegetation include:

- coating above water and above ground vegetation,
- toxic effects of microorganisms involved in the degradation of oil,
- displacement of the air in the soil by oil (Wein 1971).

The effects of cleanup operations on the vegetation in the vicinity of oil spills would depend upon the method used. Destruction of estuaries would have detrimental effects on the aquatic and terrestrial organisms which utilize them. The more protected, predominantly freshwater-influenced estuaries would be less susceptible to damage than would the saline estuaries.

TERRESTRIAL WILDLIFE

Increased vessel traffic through Chatham Strait, Lynn Canal, and Taiya Inlet during construction may slightly influence coastal feeding and scavenging behavior, particularly of the bald eagle, brown bear, Sitka black-tailed deer, waterfowl, and some furbearers.

Adverse impacts to mammals, raptors, shorebirds, and waterfowl utilizing coastal and estuarine habitats along the proposed tanker route would occur only in the event of an oil spill, fire, or explosion during operation. An oil spill reaching beach areas, river deltas, and bays and coves as well as proposed ecological reserves would have detrimental impacts as these habitats are utilized by terrestrial wildlife (see table 8.2.3-1).

TABLE 8.2.3-1 PROPOSED ECOLOGICAL RESERVES ALONG TANKER ROUTE

Proposed Reserve	Ownership	Potential Impacts
Tebenkof Bay	Federal	Oil spill
Port Walter	Federal	Oil spill
Port Herbert	Federal	Oil spill
Rowan Bay	Federal	Oil spill
Yasha Island	Federal	Oil spill
Kootznahoo Inlet	Federal	Oil spill
Auke Bay	State	Oil spill
Benjamin Island	Federal	Oil spill
Berners Bay/Echo Cove	Federal	Oil spill
Boat Harbor	Federal	Oil spill
Warm Pass	Federal	Interference with wildlife due to noise and habitat disruption and air pollution during construction
Taiya Inlet	Federal/ state	Oil spills, construction of harbor facilities, disturbance of marine wildlife due to tanker traffic

Brown and black bears feed on grasses and sedges of coastal meadows during the spring. These areas are critical food sources. Information is unavailable concerning behavioral responses to contaminated areas but bears are expected to avoid areas impacted by oil. The greatest impact would be alteration of feeding habits and removal of generally easily accessible food sources. Displacement may not be possible in some areas because of competition with mammals in established territories of surrounding areas. Long-term reduction of bear populations could result.

An oil spill may impact bears scavenging or fishing along the shoreline, particularly if spawning salmon are contaminated. Oiling of fur from direct contact with oil may occur. Disturbance from clean-up efforts and avoidance behavior of contaminated areas could further reduce available hunting and foraging sites and indirectly influence productivity, rearing of young, establishment of territories, and aggressive behavior.

Sitka black-tailed deer are vulnerable to oil spill impacts during winter and spring (figure 8.2.3-1). Due to the extreme population cycles of species and the critical nature of winter and spring habitat, an oil contaminated environment could result in decreased population levels. Impacts could be short- or long-term.

Impacts to wolves could be similar to impacts described for bears although wolves are expected to avoid oil contaminated areas. Alteration of territorial and feeding habits may occur. Long-term impacts could result if the surrounding ecological niches are filled.

Moose are sensitive to oil contamination impacting woody plants on wintering grounds. The western coastline of Lynn Canal, David Glacier drainage, Berners Bay and the Endicott, Sullivan, and Chilkat river valleys all provide winter habitat susceptible to oil spills. Moose are frequently seen in or near aquatic feeding areas and would be vulnerable to direct contamination from oil spills.

Mountain goat winter range along the low forest fringe areas of Lynn Canal would be susceptible to oil spills, increased boat traffic, and disturbance from clean-up efforts. During severe winters oil contamination of coastline areas could have long-term impacts causing reduction of the population.

Pine marten, mink, and land otter use intertidal zones to forage for marine invertebrates. Oil contamination of these could result in oiling of fur while feeding. Long term impacts also include removal of marine food sources and reduction of rocky beach habitat for denning and feeding sites.

Peregrines feed on shorebirds, passerine species, and waterfowl where swift flight over large open areas can be used to capture prey. Disturbance of meadows and open shoreline habitat or oil contamination of these areas would be detrimental. Oil contamination of feathers by contact or from contaminated prey or ingestion of oil from contaminated prey or water could occur. Additional stress during the migration effort when some are in a weakened condition could have long-term impacts. Data on oil impacts to the arctic peregrine falcon are currently unavailable.

Oil contamination impacts to the Peale's peregrine falcon are similar to that of the Arctic peregrine. Ingested sublethal oil concentrations impair liver and kidney physiological functions in waterfowl and may have a similar impact on peregrines. Oil transferred to the nest or eggs from contaminated feathers could impair the transpiration and development of the embryo. Reduced productivity would result. Behavioral irregularities may also occur.

An oil spill in any location along the tanker route could remove roosting and feeding habitats and affect nesting behavior of bald eagles. Boat traffic is a serious disturbing factor near wintering sites as well as nests. Eagles are scavengers and susceptible to oil coating from using contaminated intertidal areas and from feeding on oilsoaked marine organisms. Disturbance from human activity involved in clean-up efforts may also cause indirect impacts. An oil spill could contaminate salmon returning to the Chilkat river valley where eagles congregate. Oil contaminated salmon could cause high mortality of eagles.

Shorebirds and waterfowl are the most vulnerable to oil spill contamination along the tanker route. The bays and coves of Chatham Strait, Lynn Canal, and Taiya Inlet are important waterfowl and shorebird habitat. An oil spill in these coastal areas could have direct or indirect, short and long-term impacts.

Resident waterfowl populations would be susceptible to oil spill impacts throughout the year; however, southeast Alaska is a major resting and feeding area for millions of waterfowl and shorebirds of the Pacific flyway during migration periods. In the event of an oil spill during migration periods, populations could be susceptible to oil spill impacts.

FIGURE 8.2.3-1 COASTAL RESOURCE USE PERIODS FOR SELECTED SPECIES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Brown Bear (foraging)				—	—	—	—	—	—	—		
Black Bear (foraging)				—	—	—	—	—	—	—		
Sitka black-tailed deer (winter and spring range)	—	—	—	—	—						—	—
Bald Eagle (nesting)				—	—	—	—					
Peregrine Falcon (migration)				—	—				—	—		
Waterfowl (nesting)					—	—	—					
Waterfowl (migration)				—	—				—	—		
Shorebird (migration)			—	—						—	—	

Source: NEC 1979

TRANSPORTATION AND UTILITY NETWORKS

The only effect of construction on the Chatham Strait-Lynn Canal would be the addition of increased barge traffic. Construction of the proposed facilities would require approximately 95 barge loads during the 2 years of construction. Considering the present traffic no sizable impacts to traffic operations are expected, except during the peak of the tourist season.

The operation of the oil transportation system to Skagway will increase tanker and fuel barge traffic along the proposed route and will increase the probability of oil spills, fires, and explosions impacting southeast Alaska.

Presently Lynn Canal is a compulsory pilotage area. Pilots would be required on board tankers during passage up Lynn Canal and during the return voyage. Tankers traveling to Skagway would be met by three tugs near the confluence of the Chilkoot and Chilkat Inlets, escorting tankers north to Skagway, assisting in berthing, and escorting the ballasted tankers back to the original rendezvous point. There are no suitable anchorage locations for large tankers in the Chatham Strait-Lynn Canal waterway.

Vessel traffic, with the exception of fishing vessels, is low. As shown on table 8.2.3-2, the average vessel movement for the summer is six per day and two per day during the winter. The proposed project would increase tanker movements by an average of one movement per day for summer and winter.

TABLE 8.2.3-2 PROJECTED SKAGWAY HARBOR VESSEL TRAFFIC

	May-September		October-April	
Vessel Type	No. of Trips	No. of Movements	No. of Trips	No. of Movements
Existing				
Ferries	174.0	348.0	152.0	304.0
Cruise Ships	60.0	120.0	--	--
Tour Ships	154.0	308.0	--	--
Ore Carriers	9.0	18.0	13.0	26.0
Freighters	30.5	61.0	42.5	85.0
Barges	22.0	40.0	30.5	57.0
Total Existing	449.5	899.0	238.0	476.0
Average traffic density (movement/day)	5.9			2.2
Average year around traffic density (movement/day)		3.8		
Added traffic				
Cruise Ships	5.0	10.0	--	--
Ore Carriers	1.0	2.0	1.0	2.0
NEC Porposal	75.0	150.0	105.0	200.0
Total Projected	530.5	1,061.0	344.0	688.0
Average traffic density (movement/day)	7.0			3.2
Average year round traffic density (movement/day)		4.8		

ECONOMIC CONDITIONS

Fishery workers may take jobs on the construction project, temporarily leaving the fishing industry for guaranteed employment and wages. Although the catch in Haines is relatively steady, commercial fishing is traditionally a cyclical industry. Many fishery workers already have jobs in other sectors of the economy, augmenting those wages with income from fishing. Some of these people may skip one season of fishing for the high wages and consistent hours of the construction project. The part-time fishermen who do shift would come from throughout the region, with Haines and possibly Hoonah providing the greatest number.

The regional impact of abandonment would be limited. Some secondary or tertiary level jobs may be lost or shifted, and the fishing fleet would be expected to be able to fish in the designated ship channel without concern for the passage of tankers.

OIL SPILL, FIRE, AND EXPLOSION RISK ANALYSES

The most significant impacts would originate from large oil spills, fires, and explosions during the expected 20 year operation period. This section provides a statistical analysis of such occurrences and some estimates of their probabilities. However, even though the probability of any large disaster may appear to be remote, there is no guarantee that it will not occur on any particular day during operation.

Impacts from oil spills, fires, and explosions are discussed by individual disciplines. The variables associated with such disasters, plus lack of site-specific locations of proposed facilities, and unknown quantities of individual resources, prohibit total quantitative analysis with any degree of certainty. However, sufficient information is presented so that the reader may infer the total impact of a particular disaster given its own set of circumstances.

During the abandonment phase, NEC proposes to leave all underground facilities in place.

Oil Spill Risk Analysis

Oil spills can occur from tanker casualties while intransit or during transfer operations while a tanker is atberth. Impacts of an oil spill depend on many factors, including the volume and type of oil spilled, the location of the spill and the success of containment and cleanup efforts.

The basic statistical risk analysis techniques used to assess the risk of oil spills from tankers are presented in detail in a report by the Oceanographic Institute of Washington (1979a). The U.S. Coast Guard Pollution Incident Reporting System (PIRS) tanker spill data from 1973-1976 (Coast Guard 1978a) was used to provide an extensive analysis of spills from all causes for tankers in transit and at berth. Spills of less than 2.4 barrels (100 gallons) were excluded from the analysis. The exposure variables utilized were port calls for assessing spills at berth and distance traveled per port call for determining the frequency of spills in transit. Usage of port calls and distance traveled does not account for all of the factors contributing to spill risk, but does allow the best possible estimation of risk.

Statistical procedures were used to provide an indication of the uncertainty of calculated expected spill frequency values. An analysis of spill magnitudes was performed to identify the historical average spill size from tankers in transit and at berth). Data on spills in Alaska were analyzed, but were insufficient as a data base for acceptable statistical analysis. The spill rates for Alaska were within the confidence limits established for the eight major port systems. Therefore, the historical U.S. spill rate was used for these analyses.

In-transit Tanker Spills

A comprehensive perspective on the risk of existing tanker oil spills in transit can be obtained by assessing the spill frequency of different sizes of spills. These estimates are shown in table 8.2.3-3. The basic in-transit spill frequency is estimated to be one spill, of 2.4 barrels or more in 7.2 years. The frequency of occurrence of a specific spill size range will be less than this basic rate. Relatively small spills of 2.4 to 100 barrels are estimated to occur once in 15 years. Very large spills (greater than 10,000 barrels) have a lower expected frequency of occurrence, estimated to be one spill in 220 years for the existing tanker traffic traveling to harbors within greater Chatham Strait.

Expressions of probability are useful indicators of future events, but caution must be taken to avoid misinterpretation of estimated values. One spill every 'X' years expresses a calculated rate and does not indicate when the spill may occur. The estimate will remain valid only if conditions do not deviate significantly from historical patterns.

TABLE 8.2.3-3

TANKER OIL SPILL MAGNITUDES IN TRANSIT 1/

(Spills≥2.4 Barrels)

Spill Magnitude (barrels)	Existing 2/ One spill in	Estimated Spill Frequency and Uncertainty Incremental 3/ One spill in	Combined 4/ One spill in
2.4-10	15 years (9 - 52)	3.5 years (2.1 - 12)	2.9 years (1.7-9.8)
10.1-50	34 years (20 - 120)	7.8 years (4.6 - 27)	6.3 years (1.7-9.8)
50.1-100	150 years (87 - 510)	34 years (20 -120)	28 years (16 - 95)
101-200	88 years (52 - 300)	20 years (12 - 70)	17 years (9.8-57)
201-2,000	110 years (66 - 380)	26 years (15 - 88)	21 years (12-72)
2,001-10,000	88 years (52 - 300)	20 years (12- 70)	17 years (9.8-57)
10,000	220 years (130 - 750)	51 years (30 - 170)	41 years (24 - 140)
All spills≥2.4 barrels	7.2 years (4.3 - 25)	1.7 years (0.98 - 5.7)	1.4 years (0.8 - 4.7)

Source: NEC 1979

1/ The ranges shown in parentheses are estimates of the uncertainty based on the 95 percent confidence limits derived from the historical spill rate.

2/ The existing spill frequency is estimated using the historical spill rate and the existing tanker traffic in Greater Chatham Strait.

3/ The incremental spill frequency is estimated using the historical spill rate and the proposed NEC tanker traffic.

4/ The combined spill frequency includes both existing and incremental spill frequencies.

The risk of in-transit oil spills from the additional tankers was assessed. Table 8.2.3-3 shows the estimated spill risk for tanker traffic to Skagway. The risk of a small spill (2.4 - 10 barrels) from tankers in transit to the proposed transshipment facility at Skagway is one spill in 3.5 years. The estimated occurrence of a large spill (greater than 10,000 barrels) is once in 51 years.

At-Berth Spills

Estimates of the at-berth frequencies of different spill sizes for the total current existing tanker traffic are shown in table 8.2.3-4. The frequency of occurrence of a specific spill size range will be less than the basic rate of one spill in 3.5 years. Relatively small spills (2.4 - 10 barrels) are estimated to occur once in 5.2 years for the existing tanker traffic while at berth. Very large spills (greater than 10,000 barrels) have a lower frequency of occurrence with an estimated one spill in 1,700 years.

TABLE 8.2.3-4 TANKER OIL SPILL MAGNITUDES AT BERTH

Spill Magnitude barrels)	Estimated Spill Frequency and Uncertainty 1/		
	Existing 2/	Incremental 3/	Combined 4/
	One spill in	One spill in	One spill in
2.4-10	5.2 years (3.7-8.7)	1.4 years (1.0-2.4)	1.1 years (0.80-1.9)
10.1-50	15 years (10-24)	4.0 years (2.9-6.7)	3.2 years (2.3-5.3)
50.1-100	110 years (78-180)	30 years (22-50)	24 years (11-40)
101-200	160 years (110-270)	44 years (31-73)	34 years (25-57)
201-2,000	150 years (100-240)	40 years (29-67)	32 years (23-53)
2,001-10,000	700 years (500-1200)	190 years (140-320)	150 years (110-250)
≥10,000	1,700 years (1200-2900)	480 years (340-810)	380 years (270-630)
All Spills ≥2.4	3.5 years (2.5-5.8)	0.97 years (0.69-1.6)	0.76 years(0.54-1.3)

Source: NEC 1979

1/ The ranges shown in parentheses are estimates of the uncertainty based on the 95 percent confidence limits derived from the historical spill rate.

2/ The existing spill frequency is estimated using the historical spill rate and the tanker traffic in Greater Chatham Strait.

3/ The incremental spill frequency is estimated using the historical spill rate and the proposed NEC tanker traffic.

4/ The combined spill frequency includes both existing and incremental spill frequencies.

A detailed examination of the risk of oil spills at berth for traffic was performed by using the historical cumulative probability of at-berth spills. This yielded the frequencies for specific spill size ranges for tankers docking at the transshipment facility. Table 8.2.3-4 presents the frequencies of spill magnitudes for tankers berthed at Skagway. The estimated frequency of a relatively small spill (2.4 - 10 barrels) from these tankers is one spill in 1.4 years. The frequency of a very large spill (greater than 10,000 barrels) is once in 480 years.

The amount of oil spilled each year by tankers in transit and at berth can be estimated using the calculated frequency of occurrence of a spill and a representative spill size. The overall frequencies that were determined for spills are the best estimates for the occurrence of an oil spill of 2.4 barrels or larger. Average spill sizes were calculated for tanker spills in transit and at berth, based on the historical spill magnitudes from 1973 to 1976. These average spill sizes are the representation of the expected magnitude in the event of an oil spill. Together the estimated spill frequency (in spills per year) and the average spill size yield the expected volume of oil spilled by tankers in transit and at berth.

The historical average spill size for tankers in transit for the eight major port systems and the years 1973-1976 was 864 barrels. For tankers at berth the historical average spill size was 122 barrels. Recorded oil spill volumes are highly variable. It is difficult to predict spill size due to the fact that most spills are relatively small so the few extremely large spills distort the data base.

Table 8.2.3-5 presents a comparison of the expected spillage from the existing tanker traffic in greater Chatham Strait and from tankers which would utilize the port near Skagway. By combining the historical average spill sizes with the appropriate spill rates calculated for greater Chatham Strait, the existing and incremental oil spillage risks for tankers in transit and at berth were determined. The present spillage risk from tankers in transit is 120 barrels per year and is 35 barrels from tankers at berth (for spills 2.4 barrels or larger).

The incremental spillage risk for the proposed project tankers in transit is 517 barrels per year and is 126 barrels per year for those tankers at berth. The combined spillage risks are 637 and 161 barrels per year respectively.

TABLE 8.2.3-5 EXISTING AND INCREMENTAL OIL SPILLAGE PER YEAR FROM TANKERS IN TRANSIT AND AT BERTH

(Spills ≥2.4 Barrels)

	Volume of Oil Spilled Per Year (Barrels per Year)	
	In Transit	At Berth
Existing1/	120	35
Incremental2/	517	126
Combined3/	637	161

Source: NEC 1979

1/ The existing volume of oil spilled per year is estimated using the historical spill rate and magnitude, and the existing tanker traffic in greater Chatham Strait.

2/ The incremental volume of oil spilled per year is estimated using the historical spill rate and magnitude, and the proposed pipeline system tanker traffic.

3/ The combined volume of oil spilled per year includes both existing and incremental oil spills.

There are more than 24 petroleum product storage sites with a total capacity of more than 466,000 barrels in the greater Chatham Strait area, including bulk petroleum storage facilities, marine terminals, and marinas. Most of the storage tanks are within a mile of a waterway, thereby creating the possibility of a spill that could reach the marine environment.

The NEC proposal would require an onshore tank storage facility at Skagway to store crude oil. Volume is estimated to be 4.1 million barrels, using 8 tanks of 510,000 barrels each. In addition, the existing White Pass petroleum products storage facility at Skagway (21 tanks; 190,600 barrels total capacity) would be replaced by four 40,000-barrel capacity tanks for CANOL Line storage, resulting in a total capacity for the new storage facility of 4.24 million barrels.

The basic statistical risk analysis techniques and the specific adaptations utilized to determine the risk of oil spills from storage facilities are presented in detail in a report by the Oceangraphic Institute of Washington (1979a). The U.S. Coast Guard Pollution Incident Reporting System (PIRS) onshore storage facilities spill data from 1973-1976 (Coast Guard 1978) was used to provide information on the occurrence of onshore storage facility spills from all causes throughout the United States. Only spills of 2.4 barrels or larger were included in the analysis because of the questionable accuracy of complete reporting of small spills. The exposure variable selected was volume stored as the risk exposure variable does not account for all of the factors contributing to spill events. The correlation and rate obtained provide the best possible estimate of storage facility spill risk.

To estimate the frequency of oil spills from the storage facilities in the greater Chatham Strait area, the calculated historical crude oil storage facilities spill rate was used. It was assumed that storage facility spill frequencies were independent of the type of oil being stored. A preliminary analysis of spills from product storage tanks revealed that spills from tanks storing crude oil and those storing petroleum products were approximately the same.

The maximum existing spill risk in the Greater Chatham Strait area is represented by the total storage capacity of the area and is estimated to be one spill in 12 years. Rarely, if ever, would all of the storage tanks be full and present this maximum spill risk. However, this spill frequency does represent the highest possible existing risk of oil spills from onshore storage facilities.

Estimates of the frequencies of different spill magnitudes for the current storage facility capacity in the greater Chatham Strait area are shown in table 8.2.3-6. Relatively small spills are estimated to occur once in 35 years. A large tank farm spill, 1,001 to 10,000 barrels, has a frequency of occurrence of one spill in 1,100 years.

TABLE 8.2.3-6 ONSHORE STORAGE FACILITY SPILL MAGNITUDES

Spill Magnitude (barrels)	Estimated Spill Frequency and Uncertainty 1/		
	Existing 2/	Incremental 3/	Combined 4/
	One spill in:	One spill in:	One spill in:
2.4-10	35 years (28-44)	3.8 years (3.1-4.8)	3.5 years (2.9-4.5)
10.1-100	25 years (20-32)	2.7 years (2.2-3.5)	2.5 years (2.1-3.3)
101-1,000	91 years (74-120)	9.9 years (8.1-13)	9.2 years (7.5-12)
1,001-10,000	1,100 years (920-1,400)	120 years (100-160)	110 years (93-150)
All Spills $\geq$ 2.4 barrels	12 years (10-16)	1.4 years (1.1-1.7)	1.3 years (1.0-1.6)

Source: NEC 1979

1/ The ranges shown in parentheses are estimates of the uncertainty based on the 95 percent confidence limits derived from the historical spill rate.

2/ The existing spill frequency is estimated using the historical spill rate and the onshore storage volume in Greater Chatham Strait.

3/ The incremental spill frequency is estimated using the historical spill rate and the proposed onshore storage facility volume.

4/ The combined spill frequency includes both existing and incremental spill frequencies.

The expected spill frequency for the proposed onshore storage facility is once in 1.4 years for a spill greater than 2.4 barrels. The combined spill frequency from both the existing facilities and the proposed new facility is only slightly higher, one spill in 1.3 years, as the existing oil storage capacity in the area is considerably less than the capacity of the new facility.

The estimated spill magnitude frequencies for the onshore storage facility are shown in table 8.2.3-6. A small spill (2.4 - 10 barrels) is expected to occur once in 3.8 years. Large spills have a lower frequency and are estimated at one spill in 120 years.

The expected yearly volume of oil spillage from storage facilities in the Greater Chatham Strait area was estimated for the existing storage facility sites and for the proposed onshore storage facility at Skagway. These estimated annual spill volumes are shown in table 8.2.3-7. The maximum baseline risk of oil spillage from the existing storage facilities was determined to be 5.6 barrels per year. The increment of the proposed storage facility spillage risk is 51 barrels per year. The combined oil spillage risk of 55 barrels per year is less than the sum of the existing and incremental oil spillage risks because some of the proposed new storage tanks are replacing existing facilities.

TABLE 8.2.3-7

EXISTING AND INCREMENTAL OIL SPILLAGE PER YEAR FROM ONSHORE STORAGE FACILITY

	Volume of Oil Spilled Per Year (Barrels per Year)
Existing1/	5.6
Incremental2/	51.0
Combined3/	55.0

Source: NEC 1979

1/ The existing volume of oil spilled per year is estimated using the historical spill rate and magnitude, and the existing petroleum storage capacity in Greater Chatham Strait.

2/ The incremental volume of oil spilled per year is estimated using the historical spill rate and magnitude, and the proposed capacity of the onshore storage facility.

3/ The combined volume of oil spilled per year includes both existing and incremental oil spills.

Tank Barge Spills

Approximately 300 port calls are made by tank barges in greater Chatham Strait each year. Tank barges are susceptible to the same hazards which confront other vessels and therefore constitute a potential source of oil spills.

Non-petroleum cargo vessels traversing the area vary in size and purpose. The majority of these vessels create oil pollution; bilges are pumped regularly. Oil from engine breakdowns and fuel supply leakage is usually present in the bilge water. Many spills occur during fueling; overfilling of fuel tanks often occurs with the surplus flowing overboard. Hoses, valves, and pumps leak oil at times. Many inboard engines discharge exhaust through cooling water effluent which can release oily water. Outboard motors are mostly two-cycle engines requiring lubricating oil mixed into the fuel supply. The oil is not burned completely and enters the environment through the cooling water and exhaust. Portable tanks used by most outboards often leak fuel. Collisions, groundings, and sinkings are infrequent, but they do occur, often with the loss of an entire fuel supply.

The oil spill risk contributed by the tank barge traffic was determined by basic statistical risk analysis techniques presented in detail in a report by the Oceanographic Institute of Washington (1978d). As shown in table 8.2.3-8, a tank barge spill is expected once every 3.1 years. Using the average spill size for tank barges of 161 barrels, the expected volume spilled from barges is calculated to be 51.5 barrels per year. There were, however, no tank barge spills reported in greater Chatham Strait in the 5 years from 1973-1977.

Oil Spill-Other Vessels

The amount of oil discharged by commercial and recreational vessels is difficult to determine since the data base is limited and estimates can be inaccurate and misleading. However, if the spill is large enough to be noticed, it may be reported by the U.S. Coast Guard Pollution Incident Reporting System (PIRS). Table 8.2.3-8 also presents the average amount of oil spilled per year in greater Chatham Strait (1972-1977) calculated for each vessel type. The use of an average spill size taken over several years, rather than the spill volume from the most current year, minimizes the spill volume variations which occur from year to year as a result of fluctuations in the vessel traffic.

Fishing vessels spill the largest amount of oil per year of these non-petroleum cargo vessels. Sinking causes the largest number of spills and accounts for the largest volume of oil spilled. Spills produced an average volume of 9.2 barrels per year from fishing vessels and 2.9 barrels per year from passenger vessels.

TABLE 8.2.3-8 SPILLS OF VESSELS OTHER THAN TANKERS IN GREATER CHATHAM STRAIT

Vessel Type	Average Number of Spills One spill every:		Average Volume Spilled per Year (Barrels)
Tank Barge	3.1 years		51.5
Non-petroleum Transporting Vessels			
Dry Cargo Barge	5.0 years		0.01
Tug	1.3 years		0.35
Fishing Vessel	0.4 years		9.19
Passenger Vessel	2.5 years		2.88
Recreational Vessel	1.0 years		0.31
Other Public Vessel	1.3 years		0.40
Coast Guard Vessel	5.0 years		0.005
Unknown Vessel	1.7 years		0.11
Cumulative	0.14 years	Total	64.75

Terrestrial Sources of Oil Pollution of the Marine Environment

Knowledge of existing oil inputs to the greater Chatham Strait area from other sources (all land sources excluding oil storage facilities and pipelines) is essential for assessing the magnitude of petroleum pollution if the NEC proposal is implemented. This input represents an addition of oil which often goes unnoticed or is not monitored but has cumulative effects upon the marine environment.

Such an analysis is concerned with estimating the quantity of potential oil inputs from municipal wastewater, industrial wastes, urban runoff, and land accidents resulting in oil spillage. Other potential sources include river runoff and atmospheric fallout. The latter two sources were not analyzed.

The inputs of oil to the greater Chatham Strait area from municipal wastewater and industrial wastes were calculated from estimates formulated by the National Academy of Sciences (1975) on a per capita basis. Per capita contributions of oil ranged from 3 to 13 grams per day (National Academy of Sciences 1975). Within these values, approximately 50 percent would result from municipal wastewater including gas stations, garages, and commercial operations) and the remaining 50 percent would result from a variety of industrial wastes discharged to the municipal sewage system. The per capita contribution obtained by extrapolation for the greater Chatham Strait area was 4 grams per day for all municipalities.

Conversions were made to obtain barrels per year. The estimated oil inputs are 274 barrels per year for a population of 26,720.

Significant amounts of oil are deposited in urban areas from operation of automobiles, spent lubricating and waste oils, and fallout. The quantity of oil inputs depend on the extent of human activity and are therefore related to population density and petroleum utilization.

The National Academy of Sciences estimates used for the municipalities treat urban runoff as a separate entity from municipal and industrial wastewater. This procedure was formulated by research conducted in major U.S. coastal cities which found that best estimates would be obtained by treating urban runoff as a fraction (50 percent) of the total oil input from municipal and industrial wastewater (NAS 1975). This fraction represents the additional incremental contribution of oil from urban runoff.

The estimated contribution of oil from marine and land-based transportation facilities to the existing level of inputs to the greater Chatham Strait area from land sources was determined from U.S. Coast Guard Pollution Incident Reporting System (PIRS) data. The source of spill, average number of spills, and average spill volume are presented in table 8.2.3-9.

In order to provide a perspective as to the magnitude of oil inputs originating from all land sources excluding oil storage facilities and pipelines, the total estimated contribution of oil from each of these sources is presented in table 8.2.3-10. The total estimated input of oil into the greater Chatham Strait area from other sources is 475 barrels per year. The largest source of oil was determined to be the effluent discharge of municipalities and industries.

TABLE 8.2.3-9 SPILLS OF MARINE AND LAND TRANSPORTATION FACILITIES

TO THE EXISTING LEVEL OF OIL INPUTS

(1973-1977)

Spill Source	Average Number of Spills One spill every:		Average Volume Spilled per Year (barrels)
Marine Facilities	0.6 year		2.19
Land Vehicles	1.7 years		.09
Land Facilities	2.5 years		.07
Other Facilities	0.4 years		56.55
Miscellaneous	0.4 years		5.28
Cumulative	0.13	Total	64.18

Source: NEC 1979

TABLE 8.2.3-10 ESTIMATED ANNUAL SPILLS OF

OIL FROM OTHER SOURCES

Spill Source	Estimated Oil Input (barrels/year)
Municipal Wastewater and Industrial Waste	274
Urban Runoff	137
Marine and Land Transportation Facilities	64
Total	475

Source: NEC 1979

The baseline level of oil spillage in greater Chatham Strait is presented in table 8.2.3-11. The total, which is composed of estimated actual and risk spills, is 730 barrels per year. The largest source is shown to be the daily discharge of municipal wastewater and industrial wastes, while the next largest component is from tank vessels carrying petroleum products.

Comparison of Existing Spill Risk and NEC Increment

The proposed NEC system would cause an increase in three existing sources of oil spill. Tankers in transit and at berth, storage facilities, and pipelines would all constitute an additional increment of oil spillage risk. The increment of risk estimated for each system component and for the entire proposed NEC system is presented in table 8.2.3-11.

TABLE 8.2.3-11 COMPARISON OF EXISTING AND INCREMENTAL OIL SPILL RISK

Type of Oil Spill Risk		Existing Risk (barrels/year)	Incremental Oil Spill Risk Due to Proposed Northwest Energy Transshipment System (barrels/year)
Tankers In-Transit	-	120	517
Tankers At-Berth	-	35	126
Oil Storage Facilities	-	6	51
Tank Barges	-	52	
Pipelines	-	29	23
Other Vessels	-	13	
Land Sources	-	475	
Total		730	717

Source: NEC 1979

Tankers have the highest potential oil spillage risk particularly while in transit. The estimated average of 643 barrels of oil spilled annually would be solely from the proposed tankers.

The land components of the system constitute an average annual input of 51 barrels from pipelines. Construction activities may provide a few barrels of spilled oil until the facility is completed. Once operational, no sources other than those already quantified are anticipated.

The current level of risk of oil inputs from all sources in the area around greater Chatham Strait is estimated to be an average of 730 barrels per year. The estimated increment associated with the proposed NEC system is an average of 717 barrels per year. Operation of the proposed NEC system would therefore increase the risk of oil spillage in the Greater Chatham Strait by 98 percent. The additional tanker traffic would increase the existing tanker oil spillage risk by 415 percent since there is very little existing tanker traffic. The maximum potential oil spillage from the proposed onshore storage facilities would constitute an 850 percent increase in the existing risk of spills from storage tanks around the greater Chatham Strait. Again, the high percentage increase is somewhat misleading since there are currently no large crude oil tank farms in the area.

Oil Spill Trajectories

The six areas selected as sites for potential oil spills were chosen because of concern for navigational safety. The sites were thought to be unsafe from a navigational standpoint because of the existence of shoal areas, extreme environmental conditions, or convergence zones for vessel traffic. The sites:

- East of Indian Rock;
- East of Battery Point;
- East of Eldred Rock;
- West of Hump Island;
- Hanus Reef; and
- West of Point Gardner.

A computer model was run at the six spill sites for winter and summer primarily because of the 180° shift in the prevailing wind direction between these two times of the year. In winter, the prevailing wind direction at all of the sites was assumed to be northerly, averaging about 25 knots at Indian Rock and decreasing to 10-11 knots at Point Gardner. The 6-hour wind periods did not all have the same wind speed at each site; they increased and decreased in a fairly random sequence but did retain the prevailing direction during each of the two seasons. In addition, the summer sea breeze condition was considered by increasing the southerly wind at all of the sites by 5-10 knots during the 6-hour period from 1200 to 1800 hours.

The tidal currents employed in the model were taken from the National Ocean Survey (NOS) tidal current tables and represented the tidal currents for a mean tide during the period of interest. Because of the question as to whether the NOS tidal current predictions contain the non-tidal estuarine component, there was no attempt to enter a reasonable value for the non-tidal estuarine current in the model.

The analysis was made for a 24-hour period because it was felt that this was a realistic, yet critical, response time for containing a spill in less than ideal environmental conditions. The period was initiated at the beginning of the ebb current phase of the tidal cycle and continued through two complete tidal cycles, i.e., 2 floods and 2 ebbs.

The volume of oil spilled on the surface of still water does not remain in its original state. Oil spreads outward under the influence of gravity and surface tension forces and would be retarded by inertial and viscous forces. The physical characteristics of the oil which determine the rate of spread and the final slick size are the size of the spill, the mass density and viscosity of the oil, and the nature of the resulting surface tension and viscous interaction between the oil and the water.

Fay (1969, 1971) and Hoult (1972) have developed the equations which describe the spreading processes discussed in the preceding paragraph. The method was developed assuming a motionless, calm sea surface. Although it may be possible to employ the theory of Fay and Hoult in well protected areas where wind, current, and wave effects are minimal this theory or any alternate theory may not adequately describe the phenomenon of oil spreading in exposed areas. For this reason there was no attempt in this study to quantitatively address the spreading process. A specific volume of oil has not been used in the modeling. The actual transport of the oil should not be radically different for various oil spill sizes; the oil concentration and rate of spreading will vary. It should be noted that the model treats the spill as an instantaneous discharge of a volume of oil rather than a continous spill over a period of time.

The trajectories generated at each of the six sites for the two seasons are presented in the Map Addendum. In addition to the six sites, an analysis of the expected movement of oil from a spill in Skagway harbor was also performed. The results are indicative of where the oil would move under average conditions, but the wind and tide could create a different response. Certain assumptions and extrapolations from known quantities were made in order to derive meaningful input data for the model. Spreading is presented as a qualitative interpretation of the effects of waves, nearshore currents, and localized variations in freshwater runoff.

The wind generated current was the predominating force affecting the oil at the six sites during both winter and summer. During summer the winds were light enough at the southerly spill sites so that a limited amount of tidal oscillation was present. The coupling between the wind and the water resulted in the wind-generated current being directed to the right of the direction toward which the wind is blowing. The narrow configuration of the channels and the strength of the winds, therefore, result in the oil impacting a shoreline for the remainder of the time period. The oil would tend to move along the shoreline and into the numerous bays and inlets in the area.

Rougher sea characteristic of the winter months would affect a significant breakup of the oil sick compared with the summer season.

The lengthy southward transport characteristic of all the trajectories generated in Lynn Canal during the winter season is suspect. The apparent inclusion of the seaward directed estuarine flow in the NOS tidal current predictions in Lynn Canal creates a strong southerly current component in this area which is probably not present during the winter seasons when freshwater dischage is lowest. During the summer, this southerly current will counteract the effects of the southerly summer winds and the extent of oil transport would not be extensive. In addition, the high river discharge during the summer will create numerous localized areas where the oil will tend to be carried away from shore and out of estuarine environments. It should be noted, however, that strong summer sea breezes could easily overcome this tendency.

The results at the Indian Rock site are included in the Map Addendum. The general movement of the summer trajectory is to the north and east impacting land after approximately 4 hours and affecting the eastern shoreline of Taiya Inlet from Low Point to 1.5 miles north of the gravel slide area. Spreading oil would probably not reach the western shoreline in the 24-hour time period. The winter trajectory impacts Chilkat Peninsula after 6 hours and subsequently impacts most of the eastern shoreline of the peninsula. Spreading oil would probably not reach the eastern shoreline of Chilkoot Inlet.

The trajectories generated at Battery Point are included in the Map Addendum. The summer trajectory follows a similar path to the one at Indian Rock, impacting the shore line from the Katzehin River delta to south of Skagway in the 24-hour period. The winter trajectory moves to the south and west, impacting Chilkat Peninsula, Sullivan Island, and the western shoreline of Lynn Canal from north of Sullivan Island to Danger Point. The length of this trajectory is probably unrealistic due to the over-compensation of the estuarine surface flow in the tidal currents.

The results for the Eldred Rock site are included in the Map Addendum. The summer trajectory is transported to the north and east, impacting the eastern shoreline of Chilkoot Inlet at approximately 10 hours after oscillating under the tidal influence. The oil moves along the shoreline, reaching a point opposite the southern end of Sullivan Islands in 24 hours. The winter trajectory is transported diagonally across Lynn Canal, under the influence of the northerly wind, impacting the western shoreline and continuing south to Point Whidbey. As before, the length of this winter trajectory is suspect.

The trajectories generated at the spill site to the west of Hump Island are presented in the Map Addendum. The summer trajectory is transported to the east and north, impacting Shelter Island after 12 hours, continuing through the channel between Shelter and Lincoln Islands and impacting the main shoreline in the vicinity of the Eagle River delta. Spreading oil would probably cause most of Hump Island, Shelter Island, Lincoln Island, and other small islands to be impacted. It should be noted that the flood tidal currents in Saginaw Channel and Favorite Channel flow to the south, and ebb currents to the north. The winter trajectory is transported to the south and west impacting the shoreline in the vicinity of Point Howard and continuing south across Icy Strait. Spreading oil would impact the small islands in the vicinity of Point Couverden.

The results for the Hanus Reef spill site are presented in the Map Addendum. Due to the lighter summer winds in this area, there is tidal oscillation evident in the result for this season. The oil is transported both to the north and the south of the spill site, impacting the shoreline to the north and east of Point Gardner. The spreading of the oil would result in the small inlets and coves in this vicinity being impacted. The winter trajectory also shows some tidal oscillation due to the stronger tidal currents in this area. In general, the oil is transported to the southwest, and would impact Red Bluff Bay and Hogatt Bay as well as the shoreline to the north of these inlets.

An oil spill occurring in the Skagway harbor area will be transported in either of two different directions depending upon the wind conditions existing at the time of the spill. The wind will provide the dominant force for oil movement in this area, masking the tidal currents throughout the year and the estuarine surface flow during times of low freshwater discharge from the Skagway river. During summer months the prevailing southerly direction of the wind will tend to concentrate the oil within the harbor. However, any oil that spreads around the ore dock will be carried to the south and west by the freshwater discharge from the Skagway River. Due to the heavy concentration of oil transported into the harbor and the calmer seas characteristic of the summer months, the oil will tend to remain consolidated as one main slick within the harbor. The oil which is influenced by the river discharge, however, will break off from the main slick and be carried to the western shoreline of Taiya Inlet.

The 180° shift in the prevailing wind direction and the low freshwater discharge during the winter months will cause a different pattern of oil movement. The northerly winter winds will transport a harbor oil spill to the south, initially impacting the eastern shoreline of Taiya Inlet south of Skagway. In a period of time however, the oil will probably be transported and spread to the western shoreline. Although the winter conditions tend to result in rougher seas, there is not a long enough fetch for a northerly wind to create significant waves in the Skagway harbor area. The oil then would consolidate as a large slick within the harbor area and should only begin to break up as it moved to the south. In addition, although the discharge from the Skagway river is low during the winter months, the flow will still be great enough to prevent any surface oil from moving up the Skagway river during a flood tide. The winds would also help to prevent this. However, any oil which sinks in this vicinity could possibly be carried upstream during a stong flood tide.

Fire and Explosion Risk Analysis

The potential for a vessel casualty is a navigational risk for tankers. The potential loss of cargo from a tanker casualty resulting from a fire or explosion is an important reason for the consideration and estimation of the risk of tanker casualties. Furthermore, a tanker casualty resulting from a fire or explosion can have substantial impacts on other ships and related equipment, both at sea and at berth.

A report by the Oceanographic Institute of Washington (1979a) presents the results of the tanker casualty risk analysis performed for tankers in transit and at berth in greater Chatham Strait. The analysis resulted in the determination of the existing tanker casualty risk and the increment of risk due to the proposed tanker traffic for all types of casualties.

U.S. Coast Guard casualty data for 1969-1975 and part of 1976 (U.S. Department of Transportation 1977a) were used to provide the extensive analysis of tanker casualties from all causes.

Fires and explosions accounted for 3.88 percent of casualties. The world wide tanker (WWT) data base for the years 1969-1973 was used to obtain a percentage figure for the number of casualties caused by fires versus the number by explosions, as well as the percentage of these casualties occurring in harbor areas versus those occurring while the tanker was in a coastal area. It should be noted that casualties occurring in harbor areas are defined as those which occur while a tanker is at berth, in a harbor or river, or at the entrance to a harbor. The data were analysed in this way because of the greater number of fires and explosion casualties which occur in harbor areas and because of the potentially greater effect on other vessels, equipment and people from a fire or explosion there. The casualties occurring while a tanker is at sea were not included because these casualties would occur outside the geographical limits of greater Chatham Strait.

The relative frequencies of fires and explosions in coastal areas and in harbor areas were then applied to the tanker casualty results calculated by the Oceanographic Institute of Washington (1978c). Estimates were made of the frequency of occurrence of tanker casualties resulting from fires and explosions in both coastal and harbor areas for the existing tanker traffic in greater Chatham Strait, the proposed crude oil tanker traffic to Skagway, and the combined existing and incremental traffic.

Fires

The expected frequencies of tanker casualties resulting from fires in coastal areas and harbor areas are presented in table 8.2.3-12. Greater Chatham Strait has an expected existing fire casualty frequency of one in 140 years in harbor areas and one in 214 years in coastal areas. The proposed traffic to Skagway is expected to have a fire casualty once in 38 years in the harbor area and once in 49 years in coastal areas. The combined tanker traffic in greater Chatham Strait represents a fire casualty frequency of one casualty every 30 years in harbor areas and one in 40 years in coastal areas.

TABLE 8.2.3-12 TANKER FIRE FREQUENCY

	Estimated Fire Frequency	
	Harbor Areas	Coastal Areas
	One fire in:	One fire in:
Existing 1/	140 years	214 years
Incremental 2/	38 years	49 years
Combined 3/	30 years	40 years

Source: NEC 1979

1/ The existing fire frequency is estimated using the historical fire casualty rate and the existing tanker traffic in greater Chatham Strait.

2/ The incremental fire frequency is estimated using the historical fire casualty rate and the proposed NEC tanker traffic.

3/ The combined fire frequency includes both the existing and the incremental explosion frequencies.

Explosions

The expected frequencies of tanker casualties resulting from explosions in coastal areas and harbor areas are presented in table 8.2.3-13. Greater Chatham Strait has an existing explosion casualty frequency of one casualty in 330 years in harbor areas and one in 190 years in coastal areas. The proposed crude oil tanker traffic to Skagway is expected to suffer an explosion casualty once in 92 years in harbor areas and once in 44 years in coastal areas. The combined tanker traffic in greater Chatham Strait represents an explosion casualty frequency of one in 72 years in harbor areas and one in 36 years in coastal areas.

TABLE 8.2.3-13 TANKER EXPLOSION FREQUENCY

	Estimated Explosion Frequencies	
	Harbor Areas	Coastal Areas
	One explosion in:	One explosion in:
Existing 1/	330 years	190 years
Incremental 2/	92 years	44 years
Combined 3/	72 years	36 years

Source: NEC 1979

1/ The existing explosion frequency is estimated using the historical explosion casualty rate and the existing tanker traffic in greater Chatham Strait.

2/ The incremental explosion frequency is estimated using the historical explosion casualty rate and the proposed NEC tanker traffic.

3/ The combined explosion frequency includes both the existing and the incremental explosion frequencies.

Mathematical models were utilized to estimate the thermal radiation or heat from pool fires which could result from tanker oil spills. Distance limits for damages to people and wood buildings were calculated for two spill sizes (one wing tank of a 225,000 dead weight ton tanker or 315,000 barrels, and a worst possible spill of all cargo from that tanker, or 1.5 million barrels) and for two conditions of fire flame. These distance limits are presented in table 8.2.3-14. Although crude oil fires are known to be very smoky, large fires on slicks tend not to be fully coherent. As the pool area becomes larger, the fire burns in patches, becomes less coherent, and therefore emits less total thermal radiation. Hence, the "best estimate" distance in table 8.2.3-14 is probably conservative (high). The distance was calculated using smokeless, totally coherent flame, and therefore results in conservative estimates.

To estimate the safe distances from the tanker if there are spills at the berth, the radius of the spill must be added to the distance limits presented in table 8.2.3-14. NEC states that although the harbor area would be affected by such fires, the town of Skagway should not be damaged. Berthed cruise ships and ferries could suffer fire damage in the event of a worst possible spill and fire.

TABLE 8.2.3-14 DISTANCE LIMITS FOR DAMAGE FROM TANKER SPILL FIRES

	Distance from Wing Tank Spill 1/ (feet)		Distance from Worse Possible Spill 2/ (feet)	
	Best Estimate 3/	Conservative Estimate 4/	Best Estimate 3/	Conservative Estimate 4/
Safe distance for people	630	1,280	700	1,930
Severe burn or fatality 5/	200	525	200	620
Safe distance for wood	175	480	175	530

Source: NEC 1979

1/ Modeled for spill of one wing tank (315,000 barrels) of largest vessel (225,000 dwt).

2/ Modeled for spill of all cargo (1.5 million barrels) from largest vessel (225,000 dwt).

3/ The best estimate distance is based on a smoky fire and experimental observation.

4/ The conservative estimate distance is based on theoretical calculations and a smokeless fire.

5/ Severe third-degree burns would occur with 5 seconds of exposure, and death would occur with 10 seconds of exposure.

To evaluate the consequences of possible tanker explosions, mathematical models were utilized to determine distance limits for blast wave effects. Only a worst possible tanker explosion, involving the simultaneous explosion of all cargo tanks of a 225,000 dwt tanker was modeled. To be conservative, the model assumed a uniform mixture of fuel and air, and total detonation. Although such a uniform mixture could occur during or after the unloading operation, it is not likely that the mixture would be so perfect. In addition, accidental explosions rarely have efficiencies greater than 1 to 10 percent, so the modeling results are conservative (high).

The type and extent of damage from the worse possible tanker explosion are presented in table 8.2.3-15.

For the worse possible explosion, people within a radius of 970 feet could be killed, while people beyond 1,300 feet would be safe. If the tanker is at berth, then people in Skagway or at the cruise ship or ferry berth would be safe. However, personnel at the unloading port probably would be killed.

Structural damage around the port would be severe; windows would be shattered on cruise ships with scattered window breakage and other minor damage throughout Skagway. However, there would probably be no severe or moderate damage to structures other than at the unloading port.

TABLE 8.2.3-15 POSSIBLE TANKER EXPLOSION CONSEQUENCES
(225,000 dwt)

Type of Damage	Radial Distance (feet)
Human Casualties:	
Mostly safe	1,300
Lethality threshold	970
Lethality near 50% probability	900
Lethality near 100% probability	830
Structural Damage:	
Wood Frame	
Scattered	5,550
Moderate	2,800
Severe	2,200
Brick, Multistory	
Scattered	5,550
Moderate	2,300
Severe	1,700
Light Steel Frame Industrial	
Scattered	5,550
Moderate	1,050
Severe	750

Source: NEC 1979

Onshore Storage Facility

Fire. Fires resulting in damages greater than $1,000 which were reported from 1972 through 1976 were evaluated (API 1972-1976). The American Petroleum Institute conducts annual fire loss surveys of its member companies to determine fire-loss ratios in terms of dollars lost per dollar of net book value. This information was used to determine both frequency of fires and damage to property from fires at oil storage facilities. The frequency used by API was fires per 100 properties. Frequencies using other exposure variables, such as fires per tank-year or fires per barrel throughput, were not available from any known data source. In addition, the fire data is not comprehensive for all U.S. tank farm fires, only for those whose companies voluntarily reported. However, 83 to 120 companies and their subsidiaries participated in various years, giving a fairly large data base of about 1,110 tank farm years of experience. Explosions were not reported separately, so the following analysis for fires does not provide information for onshore storage facility explosion rates.

The API fire loss data was analyzed to estimate the fire frequency and uncertainty for the proposed NEC storage facility. It is assumed that the site of the facility in Skagway does not inherently present a risk from an earthquake fault or some other geologic hazard. No existing risk frequencies for the greater Chatham Strait area were determined. Table 8.2.3-16 indicates the risk of fire resulting in damages greater than $1,000 for the proposed onshore storage facility.

TABLE 8.2.3-16 ESTIMATES OF FREQUENCIES OF FIRE DAMAGE MAGNITUDE, ONSHORE STORAGE FACILITY

Fire Loss Magnitude $	Fire Frequency and Uncertainty1/
1,000 - 10,000	140 years (83 - 560)
10,000 - 100,000	290 years (170 - 1,100)
100,000 - 500,000	230 years (130 - 880)
500,000	1,100 years (600 - 4,100)
1,000	64 years (36 - 250)

Source: NEC 1979

1/ The ranges shown in parentheses are estimates of the uncertainty based on the 95% confidence limits derived from the historical fire rate.

Although the fire frequencies present an overall view of the risk, they do not address the actual amount of damage that might occur. To calculate the expected damage size distribution for the proposed storage facility, the historical API Fire loss sizes were analyzed. Combining the fire frequency estimate given previously with this information on damage size distribution, expected incremental damage estimates were calculated and also are presented in table 8.2.3-16.

The proposed transshipment system would employ about 60 people; the estimate for facility fire or explosion would be one death in 715 years. Estimates of fatalities or injuries to people near the facility, but not employed by NEC are not available.

Mathematical models were utilized to estimate the thermal radiation or heat from pool fires which could result from storage tank oil spills (see OIW 1978c). Distance limits from the perimeter of the involved tank for damages to people and wood buildings were calculated and are presented in table 8.2.3-17.

The safety of people in the vicinity of a storage tank fire is of concern. The "best estimate" figures indicate that people working in the booster pump station buildings or the central control administration building, which are the buildings closest to the storage tanks, would be safe. NEC empoyees driving along the service road at the time of a storage tank fire could be severely injured or killed. Travelers on the Skagway-Carcross highway could be severely burned. Otherwise, people and property should be safe.

TABLE 8.2.3-17 DISTANCE LIMITS FOR DAMAGE FROM A STORAGE TANK FIRE

(510,000 barrels)

	Best Estimate 1/ (feet)	Conservative Estimate 2/ (feet)
Safe distance for people	300	590
Severe burn or fatality	120	250
Safe distance for wood	110	220

Source: NEC 1979

1/ The best estimate distance is based on a smoky fire and experimental observation.

2/ The conservative estimate distance is based on theoretical calculations and a smokeless fire.

3/ Severe third-degree burns would occur with 5 seconds of exposure, and death would occur with 10 seconds of exposure.

Explosion

The consequences of possible storage facility explosions were modeled in a manner similar to tanker explosions (see OIW 1979a). For the models it was assumed that one storage tank containing an ideal mixture of fuel and air exploded with total detonation. These are both conservative assumptions leading to higher estimates of damage than would actually be expected to occur from an explosion. The type and extent of damage from this storage tank explosion are presented in table 8.2.3-18.

For the modeled storage tank explosion, people within a radius of 660 feet could be killed, while people beyond 900 feet would be safe from injuries. Depending on the location of the exploding tank, people at the central control and administration building, booster pump station building, along the service roads and Carcross highway, and just northwest of the property line could be injured. The town of Skagway might receive some scattered window shattering or minor damage, but no moderate or severe structural damage. Facilities at the onshore storage facility could be damaged.

TABLE 8.2.3-18 POSSIBLE STORAGE TANK EXPLOSION CONSEQUENCES
(510,000 Barrels)

Type of Damage	Radial Distance (feet)
Human Casualties:	
Mostly safe	900
Lethality threshold	660
Lethality near 50% probability	610
Lethality near 100% probability	560
Structural Damage:	
Wood Frame	
Scattered	3,800
Moderate	1,900
Severe	1,400
Brick, Multistory	
Scattered	3,800
Moderate	1,600
Severe	1,200
Light Steel Frame Industrial	
Scattered	3,800
Moderate	650
Severe	450

Source: NEC 1979

PORT AND ONSHORE STORAGE FACILITIES

AIR QUALITY

A comprehensive air quality analysis was not performed due to the lack of meteorological and air quality data on the site. Rather, NEC used a screening model to determine whether the proposed project would have the potential of violating air quality standards. A more thorough study would need to be performed; it would require an extensive meteorological and air quality monitoring program lasting one year. A very limited amount of modeling was performed by NEC for the operation phase to determine possible air quality impacts.

Construction Phase

Port and Onshore Storage Facilities

Pollutant emissions during construction of the proposed port and onshore storage facilities would result from the operation of construction equipment, vehicles, and earth moving activities. Emissions would consist of particulates, fugitive dust, nitrogen oxides, sulfur dioxide, carbon monoxide, and hydrocarbons. The type and number of pieces of construction equipment operating at the site would vary greatly from day to day and changing weather conditions would influence both construction activities and emission rates (particularly fugitive dust).

No quantitative analysis of predicted air quality impacts has been made. Impacts on ambient air quality would be localized in nature and confined primarily to the construction site. Major fugitive dust sources would be the concrete batch plant, portable rock crusher, and aggregate processing and stockpiling activities.

Operation Phase

At the port facility the primary pollutants present in tanker stack gasses are sulfur dioxide, Nitrogen oxides, particulates, hydrocarbons, and carbon monoxide.

Based on the high energy use and fixed position of the ship over an 18- to 36-hour period, the offloading operation was assumed to be the limiting worst case 24-hour condition.

The fuel used enroute by Valdez-Skagway vessels would have a sulfur content ranging from 1.5 to 2.0 percent by weight. The fuel used enroute by foreign tankers was assumed not to exceed 1.5 percent sulfur by weight. Because "Bunker C" fuel has a highly varied content ranging between 1 and 5 percent and averaging 2.5 to 3.0 percent (Pacific Merchant Shipping Association 1977), the 1.5 percent value may be low.

NEC stated that all tankers while berthed at Skagway would use fuel containing a maximum of 0.2 percent sulfur. The source of this fuel was not indicated. However, it is presumed that the low sulfur fuel would be transported from a west coast port.

Only one tanker at a time would berth at Skagway. The analysis assumes a 166,000 dead weight ton vessel. Visits by larger tankers, though less frequent, would result in emissions approximately 10 percent greater than those predicted for 166,000 dead weight ton tankers (SAI 1978).

In calculating flue gas flow rate, NEC allowed for a 15 percent reduction in emissions by assuming that all large tankers and most small tankers would have an inert gas system which would divert 15 percent of the flue gas to the cargo tanks during unloading. This assumption does not agree with the analysis of SAI (1978). The SAI analysis shows that the majority of both Alaskan and foreign tankers within the 90,000 to 225,000 dead weight ton range do not have inert gas systems. The use of the 15 percent reduction value may not be justified in determining a reasonable worst case condition to assure the protection of air quality standards. Additionally, NEC assumed air engine load factor of 80 percent in the calculation of fuel consumption. This does not agree with the analysis of SAI (1978) which indicates that ships greater than 150,000 dead weight ton use full power for unloading.

The predicted tanker emission rates are shown in table 8.2.3-19. Emission rates shown include those determined by NEC and those determined using the more conservative gas flow rate and engine load values which are approximately 47 percent greater.

Annual stack emissions are based on the assumption that tanker unloading operations would take place about 44 percent of the time. The leaks from the surge tank, valves, and seals were estimated from data in SAI (1978).

The U.S. Coast Guard is presently studying regulations which would require segregated ballasts by 1985 for all ships visiting U.S. ports. NEC chose not to include hydrocarbon emissions from ballasting operations. This may not be fully justified because the project, if approved, could be underway before 1985. This source of hydrocarbons should be considered in the analysis to assure protection of air quality standards in the interim. The total annual emissions from ballasting were estimated to be 116 tons per year (see table 8.2.3-20).

TABLE 8.2.3-19 EMISSION FACTORS AND EMISSION RATES FOR TANKER UNLOADING, SKAGWAY, ALASKA

	Emission Factor Distillate Oil1/ (lbs/1,000 gal)	Emission Rate (lbs/hour)	
		NEC4/	BLM5/
Particulates	15.0	13.3	26.6
Sulfur dioxide2/	28.4	25.1	50.3
Nitrogen dioxide	34.13/	30.1	60.4
Hydrocarbons	3.0	2.7	5.3
Carbon monoxide	4.0	3.5	7.1

Sources: SAI and NEC 1979

1/ From EPA (1977), Table 3.2.3-2.

2/ Assumes that fuel contains 0.2 percent sulfur by weight.

3/ Average rate between cruise and full load.

4/ The emission rate is based on the use of 1,040 gallons of fuel per hour while unloading with 15 percent of the flue gas diverted to the cargo.

5/ The emission rate is based on the use of fuel consumption values from SAI (1978) assuming full power while unloading with no flue gas diversion to the cargo.

At the onshore storage facility hydrocarbon emissions would occur from the oil storage tanks, leaks in valves and seals, and withdrawal losses. Emissions of combustions products would occur from the main pump and booster pump stations and the power plant. All units are proposed to burn number 2 grade diesel fuel containing no more than 0.2 percent sulfur. Each unit would have a 100-foot exhaust stack.

TABLE 8.2.3-20 ESTIMATED HYDROCARBON EMISSIONS--

PROPOSED PORT FACILITY (TONS/YEAR)

(530,000 Barrel Per Day Rate)

	Tons Per Year	
	NEC Estimate	BLM Estimate
Ballasting	None	116.21/
Stack Emissions	5.2	10.2
Valves and Seals	2.0	2.0
Surge Tank	0.4	0.4
Total	7.6	128.8

Source NEC 1979

1/ Assumes (1) 21 percent of foreign tankers with no segregated ballast, (2) emission of 11.4 tons for each 225,000 dwt tanker ballasting to 20 percent of their deadweight tonnage.

The fuel consumption rate and estimated pollution emission rates for the units are summarized in table 8.2.3-21. The manufacturer's estimates and emission rates calculated from the EPA Emission Factor Manual (EPA 1977) are shown for comparison. The manufacturer's sulfur dioxide and nitrogen oxide values for the main pump station are somewhat higher than the EPA values while hydrocarbon and carbon monoxide values are lower.

Emissions from the onshore storage facility were estimated from the equations in the EPA manual (1977), then standing losses were reduced by 75 pecent. The SAI analysis (1978) recommends a 40 percent reduction in standing losses calculated from the EPA manual. Losses from seals and valves were based on the study by SAI (1978).

The estimated hydrocarbon emissions from the storage tanks, power plant, and pipeline facilities are summarized in table 8.2.3-22. Estimated annual rates from both port and onshore facilities are summarized in table 8.2.3-23.

TABLE 8.2.3-21 EMISSION RATES AND STACK PARAMETERS
COMBUSTION SOURCES AT STORAGE AND PIPELINE FACILITIES

	Emission Rate per Unit (lbs/hour)					
	Main Pump Station		Booster Pump Station		Power Plant	
	Mfg. Est1/	BLM2/	Mfg. Est1/	BLM3/	Mfg. Est1/	BLM3/
Pollutant						
Particulates	—	4.1	—	1.7	—	1.7
Sulfur Dioxide	15.6	2.8	1.07	1.6	1.07	1.6
Nitrogen Dioxide	103.6	54.2	10.2	23.4	10.2	23.4
Hydrocarbons	0.96	4.5	0.78	1.8	0.78	1.8
Carbon Monoxide	2.27	12.2	6.1	5.2	6.1	5.2
Lead	—	—	—	—	—	—
Stack Parameters						
Height (feet)	100		100		100	
Diameter (feet)	2.5		1.09		1.09	
Velocity (feet per minute)	5,000		5,000		5,000	
Temperature (°F)	760		790		790	

Sources: SAI and NEC 1979

1/ Manufacturer's estimate using fuel containing 0.2 percent sulfur by weight for pump stations. Emission tests for particulates are rarely conducted. Emission rates show a wide variance according to the manufacturers.

2/ From EPA 1977 and fuel consumption rates from SAI (personal communication May 1979).

3/ From EPA 1977.

TABLE 8.2.3-22 ESTIMATED HYDROCARBON EMISSIONS,
ONSHORE STORAGE AND MAIN LINE STATION
(530,000 barrel per day rate)

	Estimated Emissions (tons/year)	
	by NEC	by BLM
Onshore Storage		
8 Crude Oil Tanks	116.7	227.9
4 Product Tanks	2.0	4.0
Main Line Station		
Valve and Seal Losses	11.0	11.0
Pumps	22.1	22.1
Total	151.8	265.0

Source: NEC 1979

TABLE 8.2.3-23 ESTIMATED ANNUAL EMISSION RATES
(tons/year)

Pollutant	Port Facility		Onshore Storage Facility and Main Line Station		Total	
	NEC	BLM	NEC	BLM	NEC	BLM
Particulates	25.6	51.3	-	65.7	25.6	117.0
Sulfur Dioxide	48.4	96.9	155.4	52.6	203.8	149.5
Nitrogen Dioxide	58.0	116.4	1,086.2	884.8	1,144.2	1,001.2
Hydrocarbons	7.6	126.4	151.8	336.0	159.4[1]	462.4
Carbon Monoxide	6.7	13.7	126.8	198.0	133.5	211.7

Source: NEC 1979

[1] Hydrocarbon emissions from the existing onshore storage facility are estimated to be 89.3 tons per year. The net increase in hydrocarbon emissions from the proposed onshore storage facility would be 70.1 tons per year according to NEC and 373.1 tons per year according to BLM estimates.

NEC used the EPA VALLEY model for sulfur dioxide as a screening technique to determine compliance with Class II incremental standards. The model assumed E stability (slightly stable) and a wind speed of 2.5 meters per second occurring for 6 hours in a 24 hour period. Due to the steeply rising terrain in close proximity to the emission sources, the highest ground level concentrations would occur on the slopes of the mountains during stable, light wind conditions. NEC therefore determined the minimum distance required between each emission source and the surrounding terrain in order to meet the 24 hour Class II incremental standards for sulfur dioxide. NEC's results are shown in table 8.2.3-24. The table also shows the actual distance between emission sources and nearest terrain.

TABLE 8.2.3-24 CALCULATED PLUME HEIGHTS AND MINIMUM DISTANCES

REQUIRED TO MEET SO_2 CLASS II LEVELS

Emission Point	Plume Height (meters above sea level)	Calculated Minimum Distance (meters)	Actual Distance (meters)
Power Plant	88	110	180
Booster Pump	99	130	300
Main Line Station	116	365	320
Tanker	85	345	167

Source: NEC 1979

Since the calculated distances for the main line pump station and for the tankers are smaller than the actual distances, it shows that those sources would be located too close to the terrain to stay within the Class II standards. Since NEC's estimated tanker emissions are low, it is evident that NEC's calculations indicate a potential problem in meeting Class II standards. More detailed analysis would be required before a definite determination can be made.

Computer modeling for particulates was performed which indicated that the tanker unloading and the operation of the main line pump station would cause the maximum allowable 24 hour increment of 37.0 ug/m3 to be exceeded. No calculations for annual average concentrations were made.

Preliminary calculations by NEC indicated that the annual average concentration of nitrogen dioxide would be within the ambient standard of 100 ug/m^3. However, more detailed analysis would be needed in order to determine specific concentrations.

No modeling was performed to determine impacts on ozone concentrations. The emissions from the proposed NEC project are estimated to range from 159 to 462 tons per year which seems unlikely to have significant effects on ozone levels.

The plume from the generating units at the onshore storage facility may be visible during light wind conditions. Plumes from the tanker stacks would be visible while tankers are unloading. No quantitative analysis was made of the effect on visual range. It is expected that under most conditions, pollutants would be dispersed rapidly and no noticeable difference in visual range would be found. However, due to the fact that Skagway is located in a narrow valley with steeply rising sides, an extended period of light winds could cause a build-up of pollutants, which could substantially reduce visual range.

In summary, this analysis indicates a moderate deterioration in air quality in the Skagway area. The most significant pollutant would be sulfur dioxide. There would be no adverse impacts on human health, vegetation, or wildlife. However, there may be periods when visibility in the Skagway area could be adversely affected.

Abandonment Phase

If abandonment plans are implemented as proposed by NEC, impacts on air quality would be confined to the onshore storage facility and main line station. Magnitude and duration of the impacts would be similar, but less than, those associated with the construction phase.

NOISE

Construction Phase

Noise impacts from construction were determined by assuming typical construction equipment for each type of operation. During the construction of the port and onshore facilities, primary noise sources would be pile-drivers, trucks, cranes, compressors, and other heavy construction equipment. Construction would continue for about 2 years and would take place during the day. Typical noise levels for pile-driving equipment can be expected to be about 65 to 70 dBA in Skagway. This compares with existing noise levels estimated to range from 50 to 55 dBA. The increase in noise would be noticeable and may cause annoyance. This is an increase of about 15 dBA over ambient noise levels, and is considered a moderate to severe impact. Blasting noise is for short periods and it was not rated .

Other construction equipment would increase noise levels by less than 10 dBA and would have a moderate impact.

Sources of noise during construction of the onshore storage facility would include earthmovers, chainsaws, trucks, cranes, compressors, and other equipment. Construction noise would be noticeable for a few months along the 42-inch pipeline route between the marine terminal and the onshore storage facility. The pipeline would pass within 600 feet of the Skagway Historic District, and noise levels of about 65 dBA would be expected in this area for a period of 1 to 2 months. This would be a severe impact if this section of pipeline were constructed during the tourist season.

Construction of oil storage tanks, a generating station, and a pump station would result in noise levels of about 60 to 70 dBA near the proposed onshore storage facility. Existing noise level are estimated to range between 50 and 55 dBA. Noticeable increases in noise levels would occur at homes located on Dyea Road about 1,000 feet from the storage facility. No adverse effects are anticipated. Lesser construction noise impacts may occur at residences along the road from the port facility as materials and equipment are transported from the harbor.

Operation Phase

During the operation phase at the port facility the primary noise source would be internal combustion machinery on tankers and tugboats. These operations would not cause any noticeable increase in existing noise levels.

The primary noise source at the onshore storage facility would be the main electrical power generating unit and booster pump station. Noise levels associated with the pump station cannot be determined at this time. However, no significant noise levels would be expected outside the onshore storage facility property.

Abandonment Phase

Noise impacts in the vicinity of the port and onshore storage facilities would be similar to those associated with the construction phase, however, they would be less since part of the structures would remain in place.

TOPOGRAPHY AND GEOLOGY

Topography

Construction Phase

The need for level sites and roads around the construction camp and headquarters site would require modification of topography on the Skagway River terrace. A construction and service road and a trench for the unloading pipeline would be required on the headland at the port location. There would be approximately 70,000 cubic yards of rock removed and the cut would constitute a modification of the topography. Approximately 15 acres within a 50 foot right-of-way would be disturbed for a period of approximately 6 months.

Construction activities for the onshore storage facility at the northern end of Skagway would involve grading and leveling 62 acres of the existing storage facility plus 11 acres of adjacent land.

Operation Phase

It is expected that operation of the port facility and onshore storage facility would have minor impacts on topography.

Abandonment Phase

Abandonment of the port facility and the underground 42-inch unloading pipeline would have little or no impact on topography. Abandonment and reclamation of the onshore storage facility would have little impact if the tanks and related facilities were removed.

Geology

Geologic Hazards

Construction, Operation, and Abandonment Phases

The impact of the proposed actions affecting geologic hazards would be limited to enhancement of slide and rockfall potential, especially along the unloading pipeline and service road near the port facility. This results from the steepening of the backslope in the rock above the cut, and localization of groundwater flow by (or in) the unloading pipeline trench in the harbor area. These may influence potential slump or differential settling due to seismic activity. The extent of these potential impacts cannot be assessed with available information.

Although no recent displacement on faults within the Skagway area has been noted, the surrounding area has not been thoroughly investigated, and it must therefore be assumed that surface rupture is possible in Skagway during the lifetime of the project. Fault movement could rupture the unloading pipeline, causing spillage of up to 22,600 barrels of oil into the Skagway River or harbor area.

Ground shaking could affect operation of support equipment, including emergency equipment. Power or communication facilities could be rendered inoperative.

Primary effects of ground shaking on the system could include failure of tanks; of connections between components of the system; of pump stations and control buildings; and of the pipe itself. The ultimate adverse impact would be caused by failure and rupture of some part of the system leading to an oil spill.

Differential settlement of alluvium might occur during earthquakes. This might affect the integrity of portions of the storage facility and unloading pipeline within Skagway.

In the event of a major landslide or submarine slide at the port facility, it is possible that the dock structure and off-loading oil line would be severely damaged. However, it is considered unlikely that a tanker at berth would be damaged under such conditions. Breakage of the unburied portions of the off-loading line during a major slide would cause spillage of oil.

Earthquake induced liquefaction of subsurface sediments near the port facility may cause surface movement of the inlet bottom however it is not known that any such submarine slide would pass underneath a berthed tanker without damaging it.

The occurrence of a tsunami is considered probable during the life of the project. The resulting damages would depend greatly on the tide stage at the time of wave arrival at Skagway. A massive seismic sea wave 50 to 100 feet high hitting Skagway would destroy the city, including the port unloading facility and would spill over 1 million barrels of oil into the marine environment. The resultant impacts on the marine environment would be major, essentially eliminating a large portion of sea life for several years and spreading oil along the southeast Alaska and northwest British Columbia coast that could take up to 10 years to clean-up.

Small rockfalls on the slopes above the port facility may be expected to be a periodic maintenance problem along the route of the unloading pipeline and wharf road. Rockfall would not be expected to cause serious damage in this area during the lifetime of the project.

SOILS

Construction Phase

Thin top soils on at least 116 acres of the unloading and onshore storage facilities would be altered, leaving them exposed to slight water erosion and runoff. A small additional amount of fine material would be lost from fugitive dust. This loss would be relatively insignificant. The soil would have a minor relative loss of productivity.

Operation Phase

Areas not under storage tanks, holding basins, parking lots, and buildings would be subject to erosion. The degree of erosion would depend upon the success of mitigation measures. If an oil spill should fail to be retained within the dikes at the onshore storage facility and contaminated the soil, the resulting impact would depend upon the topography, soil conditions, weather, and other conditions. Oil-saturated soils could remain unproductive and void of vegetation for 5 to 10 years.

Abandonment Phase

Should alternative uses for above-ground structures within the onshore storage facility be found, abandonment would have negligible impacts on the soils of the area. Removal of all above-ground appurtenances would cause a temporary increase in soil erosion. Removal of the oil unloading structures of the marine terminal would not impact the condition of the soils in the vicinity since the basic wharf and road system would remain intact. Likewise, pipeline abandonment procedures would have negligible affects on soil erosion, because NEC plans to remove the above ground structures; the unloading pipeline would be left in place.

AQUATIC RESOURCES

This section addresses fresh water resources.

Physical Components

Construction Phase

Construction of the port facility on the southern shore of the mouth of the Skagway River is not likely to significantly affect the groundwater or streams of the area. However, trenching, earthwork, grading, and paving involved in the construction of the Skagway River crossing and onshore storage facility, and associated destruction of protective vegetative cover, would alter the flow of runoff in the area. This would significantly add to temperature and suspended sediment load of small adjacent streams and the river. The magnitude of this effect would vary seasonally, depending on the amount of precipitation, background sediment load, and the particular phase of construction. With several days of heavy rainfall during which 116 acres are without vegetation or buildings, an estimated 4,300 tons of surface soil would be eroded into the Skagway River and harbor.

The effect of construction on concentrations of heavy metals in the streambed is not known. Runoff in the vicinity of the port facility, and in some small streams, may be permanently redirected or eliminated. The effects of this are not known. The level and use of groundwater is not expected to be altered.

Some leaching of any remaining zinc and lead from the dredged sediment used for construction of the onshore storage facilities may occur. This could degrade the quality of the stream and ground water.

The physical impact on the river from hydrostatic testing would depend on the rate of water withdrawal in relation to the flow rate of the river. The extent of impact will depend on the degree of dilution of the discharged water to the receiving waters.

Equipment involved in the construction of the onshore storage facility may leak or spill various substances, some of them toxic. These would be washed into the streams and groundwater and could adversely affect water quality.

Operation Phase

Since revegetation on the onshore storage facility is likely to occur; the suspended sediment load of the streams should return to pre-construction levels. Redirection of runoff and small streams resulting from construction would continue.

Runoff caught by the enclosed tank farm area will be put through an oil-water separator before it is discharged. Some contamination would occur. The magnitude of the impact of this contamination on the water quality of the streams in the area would depend on the amount of oil, the length of time involved before separation, and the degree of dilution of the discharge into the Skagway River.

Major oil spills would result in pollution of surface or groundwater. The aquatic resources surrounding the facilities would be affected for the amount of time necessary for dispersion and degradation of the oil.

Abandonment Phase

If the residual oil is flushed from the facility before abandonment, no impact would occur. Disposal of the flushing water, if discharged slowly, would have much the same impact as oil-contaminated runoff discussed previously. In the event that residual oil is not completely removed, oil leaks would occur on an irregular basis.

The redirection of both runoff and small streams initiated during construction would continue.

Biological Components

Construction Phase

Removal of streambank vegetation and instream trenching at stream crossings would cause an increase in sediment downstream from the crossing area. Sediment deposition in the fish spawning areas would reduce the number of fish produced. Fish populations would recover within several spawning cycles.

Aquatic insect production would be reduced by sediment deposition. Recovery could occur within a year.

Fuel oil spills associated with equipment operation could reduce fish and insect populations. Reduced fish populations would recover within several spawning cycles.

Operation Phase

An oil spill at the port or onshore storage facilities could impact Skagway River fisheries resources as far upstream as the extent of the saltwater wedge intrusion. The primary components to be affected would be insects and the eggs and fry of fish in or near the stream bottom. The oil would be expected to diffuse into the freshwater layer, potentially affecting larger fish. The extent of damage to fish and insects would depend on life phase and the size of the saltwater intrusion.

A large amount of oil escaping from the tanks over a short period would have an immediate adverse impact on the aquatic environment. Mortalities due to smothering and toxicity to eggs, juveniles, adult fish, and insects would be expected to occur downstream and possibly upstream if the tidal influences were great enough. Migrating anadromous fish could be severely impacted by oil toxicity. A long-term, chronic seepage of oil into the river would have less of an impact immediately but could be damaging to the ecosystem. Food fish would become tainted and unsuitable for consumption. Eggs and larvae of fish and insects could suffer from oil toxicity. A low level chronic discharge would not have as great an impact on anadromous fish migrating upstream or downstream unless they remained in the area for an extended period of time.

Abandonment Phase

Little or no impact to aquatic organisms would occur from abandonment of the storage facilities unless vegetation were removed and erosion occurred. Then, impacts as described in the construction phase would occur.

MARINE RESOURCES

Physical Component

Construction Phase

Marine resources would be affected by the construction of the port and onshore storage facilities. Dredging in the mouth of the Skagway river for the unloading pipeline would increase the suspended sediment in Taiya Inlet; the extent would be determined by the method used. This sediment may contain significant concentrations of zinc and lead. Resuspension of this sediment could increase the dissolved concentrations of lead and zinc in the water column throughout the Taiya Inlet. The suspended sediment would settle out gradually.

There may be small leaks or spills of various substances from construction equipment, many likely to be toxic. This would affect the water quality of the inlet and Skagway River to a degree dependent on the frequency, amount, and the chemical and biological characteristics of the spilled substances.

Operation Phase

Impacts could be generated by spills that occur in handling at the marine terminal or by large spills that occur from collisions, fires or explosions along the wharf. Cleanup of a large spill could be severely hampered due to waves, winds, currents, and response delays.

Abandonment Phase

The impact of the abandonment of the port facility on marine resources should not be significant; it would be similar to that of the construction phase.

Biological Components

Construction Phase

A potential impact which could result from shipping traffic through the Chatham Strait-Lynn Canal area would be the loss of major fish, wildlife, and habitat resources from oil spills or leaks. Operation of ships and barges could interfere with commercial fishing operations and could disrupt migratory routes and habitat utilization of a number of species. However, the increase in shipping related to construction would not augment current shipping to any large degree.

Construction of the berth would have only minor, localized impacts on marine resources, involving chemical or oil spills, noise, equipment operations, and degradation of water quality. The possibility would exist for potential petroleum product spills if the present storage facility is converted as proposed by NEC.

Operations in Skagway harbor may result in small spills or leaks. Generally, spills at terminals can be contained or cleaned up. However, transfer operations could be a source of chronic oil pollution to upper Lynn Canal. The strong persistent northerly winds in the Skagway area could make containment of oil spills difficult.

Abandonment Phase

Impacts on marine resources when the project is abandoned are expected to be minimal.

TERRESTRIAL VEGETATION

Construction Phase

After a survey for threatened and endangered species was completed, vegetation would be cleared for construction of the port and onshore storage facilities. Vegetation would be cleared along a 50-foot corridor (90 foot construction), 3.5 miles long between the storage and unloading facilities for the installation of an access road and the unloading pipeline (see table 8.2.3-25). About 2.5 acres would be cleared of coastal beach vegetation and the western hemlock-Sitka spruce forest.

The clearing of vegetation along the 3.5 mile unloading pipeline and port facility access road would involve the disturbance of approximately 33 acres. Approximately 8 acres would be cleared in the western hemlock-Sitka spruce forest while the remaining 25 acres would be split nearly equally between sparsely vegetated beaches and riparian vegetation.

Nearly 80 acres would be commited to the onshore storage facility and construction camp. Approximately half the area is already cleared of vegetation around existing storage tanks. The entire area is within the riparian vegetation zone.

The direct impact of clearing these areas would be minor compared to the total amount of vegetation in the area, but local impacts could be large. Some impacts would be: increased soil erosion, loss of aesthetic value, alteration of wildlife habitat, and loss of timber potential.

TABLE 8.2.3-25 ACREAGE OF SURFACE DISTURBANCE FOR ONSHORE STORAGE FACILITIES AND UNLOADING PIPELINE1/

Project Phase	Vegetation Type	Acres
Port facility	Coastal Beach2/	1.25
	Western Hemlock/Sitka Spruce Forest	1.25
Unloading Pipeline	Coastal Beach	12.5
	Western Hemlock/Sitka Spruce Forest	8.0
	Riparian	12.5
Onshore Storage Facility	Riparian	73.0
Construction Camp	Riparian	7.5
	Total	116.0

1/ Assumes a 90 foot construction corridor.

2/ Coastal beach includes some vegetation such as beach ryegrass, but is predominantly barren sands, silts, and gravels.

During construction, there could be increased danger of forest fire from use of flammable materials, operation of construction and incineration equipment, slash burning, presence of careless smokers, increases in dryness of vegetation due to altered drainage patterns, and better public access. To a limited extent, the right-of-way will act as a fire break and will provide an access route to fires.

Clearing of vegetation in the forests would expose more ground surface to sunlight. Besides increasing soil temperature, this would affect vegetation immediately adjacent to the cleared area and would influence species composition. Those species requiring shade would be eliminated, at least temporarily. The effect of this change in species composition is that the total impact area is somewhat larger than the zone physically cleared.

This change may be desirable for some wildlife species. It may be undesirable for certain species of birds, such as bald eagles, which use trees as nesting or roosting sites.

Trenching, erosion control measures, grading, soil compression, and berms left atop the pipeline trench will alter existing drainage patterns. Compression of the soil will decrease moisture penetration and increase surface runoff, leading to slower revegetation and possible alteration of downslope vegetation. Berms left atop the pipeline trench will trap runoff water and create a moisture retention area. This area will tend to revegetate more quickly than the surrounding area, possibly increasing the amount of maintenance clearing that would be necessary.

Drainage patterns may be altered. Downslope community composition could be significantly altered, and excavation of the pipeline trench would expose less fertile subsoils. If care is not taken to ensure that the topsoil is replaced in the proper sequence, revegetation of the area may be slowed.

Since the presence or absence of threatened and endangered species is unknown, impacts cannot be assessed.

Operation Phase

The greatest impact on vegetation during operation of tankers in Chatham Strait, Lynn Canal, and Taiya Inlet, or of the port and onshore storage facilities and the connecting pipeline would be:

- potential effects of oil spills, fires, or explosions,
- emissions from tankers on the vegetation (especially lichens).

During the life of the project, it would be kept free of woody vegetation to facilitate cleanup and repair procedures. Manual clearing would produce impacts similar to those outlined under the construction phase. Herbicides could be carried to surrounding areas by wind and water and would impact a larger area. Spills of toxic substances are most likely to occur in the vicinity of the port and onshore storage facilities. Impacts from these would be similar to those discussed for spills during the construction phase. Impacts on vegetation from fires or explosions would depend on the size.

Air pollution generated by tankers, pump stations, maintenance vehicles, and hydrocarbon emissions from storage tanks would potentially impact the vegetation in the immediate vicinity around Skagway. Lichens are particularily sensitive and intolerant species may be eliminated. It is uncertain what the severity of air pollution on vegetation during the life of the project would be.

It is anticipated that there would be minimal impacts to threatened or endangered species in the area during the operation of the proposed system.

All proposed ecological reserve units along the tanker route would be subjected to potential oil spills (see table 8.2.3-1). Taiya Inlet is one of the proposed reserves. Although this unit would be subject to tanker traffic and marine terminal construction and operation these uses would probably not conflict with its purpose.

Abandonment Phase

Abandonment procedures would involve the removal of all storage tanks except those necessary for local needs. After dismantling is completed, revegetation would occur.

Since the unloading pipeline is to be left buried and filled with an inert material, no further clearing of vegetation would be necessary. Because the road to the port would be left in place to serve the cargo wharf, altered drainage patterns will remain and vegetation which was affected by these changes would not recover.

TERRESTRIAL WILDLIFE

Construction Phase

Impacts to wildlife would include disturbance from noise, increased accessibility and visibility by hunters and recreationists, and alteration of existing habitat.

Expansion of the existing onshore storage facility site to accommodate a larger number of storage tanks would be minimal and would impact only wildlife utilizing adjacent western hemlock/Sitka spruce habitats.

Bald eagles drawn to the Skagway and Taiya rivers during salmon runs are susceptible to the same impacts as other wildlife utilizing this fishery resource (i.e., the detrimental effects of the consumption of oil tainted fish).

There is no documentation of waterfowl and shorebird nesting or wintering in the vicinity of the port facility. However, food resources of this area may be utilized during the spring and fall migration periods. Populations utilizing upper Taiya Inlet could suffer direct or indirect, short and long-term impacts from food contamination, as well as coating of feathers with oil.

Red squirrels, shrews, voles, and other small mammals would be displaced to other available habitats by the proposed expansion of the existing onshore storage facility and creation of a temporary construction camp. Other mammals such as black bears, coyotes, and red fox are occasional visitors to areas close to Skagway. Impacts to these species would be insignificant.

Bald eagles utilizing the forested area along the Skagway river for roosting during feeding periods would be displaced to other available roosting sites.

Impacts to waterfowl and shorebirds would be insignificant as long as a vegetative buffer is maintained between the onshore storage facility and the Skagway river.

Black bear, brown bear, mink, pine marten, and otters forage in areas adjacent to the proposed port and onshore storage facilities. Oil spills could affect food resources.

Abandonment Phase

Impacts to terrestrial wildlife during the abandonment phase of the port and onshore facilities would be insignificant.

CULTURAL RESOURCES

Construction Phase

Construction of the port facility should not significantly affect paintings on the cliff face. Changes in air quality with potential impact the rock paintings are unlikely.

Leveling and filling for the proposed onshore storage facilities could bury or destroy the old White Pass and Yukon Route railroad bed. The proposed onshore storage facility and work camp could limit identification of historic resources, if any, in the acreage adjoining the existing storage facility.

If the project should change to include the development of the ridge above the proposed site, a pioneer cemetery area could be affected. The same situation would be true for the new cemetery off the Dyea Road next to the Skagway dump.

No paleontological sites were discovered in the vicinity of the inside channel, port, and onshore storage facilities.

Operation Phase

As in the construction phase, operation involving movement of personnel, equipment, and supplies would require proper care to avoid affecting historic resources.

Abandonment

Abandonment activities could result in essentially the same impacts as those involved with construction; duration would be less.

VISUAL RESOURCES

Construction Phase

The view of the Skagway harbor would be visually dominated by the activity of cranes, barges, work platforms, and other construction vessels and equipment as the port facility is built. It would be relatively short-term. Scarring of the bluff

TABLE 8.2.3-26 VISUAL IMPACTS ON LANDFORMS

DEGREE OF CONTRAST WITH ENVIRONMENTAL SETTING VIEWED IN FOREGROUND-MIDDLEGROUND

Degree of Contrast High = 3 Moderate = 2 Low = 1 None = 0		New Right-of-way			Expansion of Existing Right-of-Way			Mainline Stations			Powerline Extensions			Block Valves at Major River Crossings		
	Weight Factor	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slopes Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less Than 5 Percent)	Steep Slope Traversed (Over 30 Percent)	Gentle to Moderate (5 to 30 Percent)	Flatlands (Less than 5 Percent
Visual Contrast Elements	Form (wt. 4)	x3=12	x2=8	x0=0	x2=8	x0=0	x0=0	x3=12	x2=8	x1=4	x2=8	x1=4	x0=0	x3=12	x2=8	x1=4
	Line (wt. 3)	x3=9	x2=6	x1=3	x2=6	x1=3	x0=0	x3=9	x2=6	x1=3	x2=6	x2=6	x1=3	x2=6	x2=6	x2=6
	Color (wt. 2)	x3=6	x2=4	x1=2	x3=6	x2=4	x1=2	x3=6	x2=4	x1=2	x2=4	x1=2	x1=2	x3=6	x2=4	x2=4
	Texture (wt. 1)	x3=3	x1=1	x1=1	x2=2	x1=1	x1=1	x3=3	x2=2	x1=1	x2=2	x1=1	x1=1	x2=2	x1=1	x1=1
Visual Contrast Rating		30	19	6	22	8	3	30	20	10	20	13	6	26	19	15

Maximum Allowable Contrast Rating:

10 = Class II	Project components should not be visually evident.
16 = Class III	Project should be subordinate to the landscape.
20 = Class IV	Project could be visually evident (could dominate landscape).

TABLE 8.2.3-27 VISUAL IMPACTS ON VEGETATION PATTERNS

DEGREE OF CONTRAST WITH ENVIRONMENTAL SETTING VIEWED IN FOREGROUND-MIDDLEGROUND

Degree of Contrast High = 3 Moderate = 2 Low = 1 None = 0	Weight Factor	New Right-of-Way					Expansion of Existing Right-of-Way					Mainline Stations					Powerline Extensions					Block Valves at Major River Crossings				
		Coniferous Forest	Ponderosa Woodland	Decidous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Decidous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Deciduous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Decidous Forest	Grassland	Agricultural Land	Coniferous Forest	Ponderosa Woodland	Decidous Forest	Grassland	Agricultural Land
Visual Contrast Elements	Form (wt. 4)	x2=8	x2=8	x2=8	x0=0	x0=0	x1=4	x1=4	x1=4	x0=0	x0=0	x3=12	x2=8	x2=8	x2=8	x1=4	x2=8	x2=8	x2=8	x0=0	x0=0	x2=8	x1=4	x2=8	x2=8	x2=8
	Line (wt. 3)	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x1=3	x2=6	x1=3	x1=3	x2=6	x1=3	x1=3	x1=3	x0=0	x2=6	x2=6	x3=9	x2=6	x1=3
	Color (wt. 2)	x2=4	x1=2	x1=2	x1=2	x0=0	x1=2	x1=2	x1=2	x1=2	x0=0	x3=6	x3=6	x3=6	x3=6	x2=4	x2=4	x1=2	x1=2	x1=2	x0=0	x2=4	x2=4	x3=6	x1=2	x2=4
	Texture (wt.1)	x2=2	x1=1	x1=1	x1=1	x0=0	x1=1	x0=0	x0=0	x0=0	x0=0	x3=3	x2=2	x2=2	x2=2	x1=1	x2=2	x1=1	x1=1	x1=1	x0=0	x2=2	x2=2	x1=1	x1=1	x1=1
Visual Contrast Rating		20	14	14	6	0	13	9	9	5	0	27	19	22	19	12	20	14	14	6	0	20	16	24	17	16

resulting from construction of the port facility would be a long-term visual impact. The use of large machinery and equipment necessary for the clearing of the right-of-way, trenching, and installation of the off loading pipeline, plus necessary rehabilitation follow-up work, would be a significant short term, adverse visual impact to residents and tourists during a two year period.

Dismantling the existing onshore storage facility and subsequent clearing, grading, and construction of the proposed one, would constitute a similar impact during a two year period.

Fugitive dust from construction activities could cause some short-term adverse visual impact. The new tanks would extend above the trees, and from a few close vantage points, would be visible in the foreground zone. These points include the railway, highway, and aircraft approach. Moderate impacts on landform and vegetation, in terms of changes in visual contrast are anticipated, persisting as a low contrast (see tables 8.2.3-26 and 8.2.3-27).

Operation Phase

Operation of the project would add the presence of the tankers and the possible effects of oil spills, fires, and explosions to the visual impacts.

Oil tankers would add to visual impacts by increasing the number of large vessels whose size is substantially greater than present ships. When viewed broadside, these tankers would visually dominate the harbor. This would constitute an adverse visual impact for some people while others would consider the tankers an interesting sight.

Any oil spills in the channel or harbor could degrade the scenic quality of the harbor and Lynn Canal--and could cause a significant impact, depending on the size of the spill and the effectiveness of cleanup operations. Visual resources at the surface level would be destroyed for several months.

During operation, especially before vegetation is reestablished, the tanks would have a signiifcant adverse visual impact on views of travelers along the Skagway-Carcross highway and on the railroad.

Abandonment Phase

Removal of the crude oil unloading equipment from the wharf platform should not cause any extended visual impact. Dismantling tanks and demolition of buildings not retained for other uses would reverse the visual impacts.

LAND USE

Construction Phase

Construction of the port and onshore storage facilities would cause direct impacts as shown in table 8.2.3-28.

TABLE 8.2.3-28 DIRECT IMPACTS - CONSTRUCTION

Project Facility	Area Occupied	Impacted Use	Description of Impact	Degree of Impact
Unloading Wharf	2.5 acres of harbor	None at present time	Impoundment of harbor area	Significant
Access road from1/ marine terminal to existing roadway		Shoreline	Change to road use	Not significant
Pipe stockpile yards	33 acres	Around port area and near airport	50-foot right-of-way plus construction area	Not significant
Onshore storage facility	73 acres	Existing onshore storage facility; state highway department maintenance building	Relocation within existing land area; displacement of building	Significant
Construction Camp	7.5 acres	Vacant land	Temporary use of land	Not significant
Storage site for material and equipment	21 acres	Port Area	Temporary use of unoccupied port area	Not significant

1/ Area is within construction right-of-way of unloading pipeline.

During the 2-year construction period for the port and onshore storage facilities, the increase in traffic due to shipment of materials would not result in significant impacts to land use along the inside channel. Within the port of Skagway and the project vicinity, the direct impact of the construction of the port would be the permanent use of 2.5 acres of land along the southeast shoreline.

The construction of the onshore storage facility would require the use of the existing 62-acre storage facility. The northern portion contains 38 acres of land with existing storage tanks. The acquisition of 11 acres of land immediately adjacent to this area would be necessary for operational buildings, bringing the total land required to approximately 73 acres.

A state highway department maintenance building located in this area might be displaced and relocated by the project.

The construction workers' camp would be located on the west of the Skagway river adjacent to the highway and would require 7.5 acres of land.

The existing port area near the ore building would be used as a staging area during the construction phase. A storage warehouse rock crusher and batch plant would be located on a 21-acre area owned by White Pass & Yukon Route.

The unloading line would have a 90-foot construction right-of-way and a length of 3.5 miles, for a total area of approximately 33 acres of land. The construction would not interfere with local streets. The primary impacts would be dust, noise, and an inconvenience to persons and vehicles crossing from the ferry terminal to the city.

Construction would interfere with urban land uses in Skagway primarily through the nuisance impacts of noise, fugitive dust, visual disharmony, and increased traffic volume. It would create a temporary inconvenience. Noise impacts would result from the use of a batch plant to be located adjacent to the ore building, from truck traffic, and from activity at the new marine terminal and at the onshore storage facility.

No significant indirect impacts induced by project construction have been identified.

Operation Phase

The direct impacts to existing land use caused by project construction would continue through the operation and abandonment phases.

It is not anticipated that project operation would cause significant indirect impacts (induced land use changes).

The dock plus the area between it and the shoreline would make permanent use of 2.5 acres of harbor surface. During berthing operations and tug maneuvering, 40 acres of harbor would be utilized for turning, docking, and unloading. Land use during the operation of the facility would be limited to the access road, the onshore storage facility, and the surface restrictions associated with the right-of-way for the unloading line.

Urban land use in Skagway would be impacted by noise, air quality, odor, fire and explosion risks, and oil spills. Odors released during the operation of the port and onshore storage facilities should not be significant.

Employees working in the immediate vicinity would be exposed to some risk in the event of fire or explosion. An oil spill within the port of Skagway could cause severe impacts to the surrounding industrial, commercial, and recreational harbor uses.

Abandonment Phase

The abandonment of the project would not result in any significant impacts to land use in the project area. NEC suggests that the unloading wharf and access road could be converted to other purposes in the port area, depending upon future needs. According to NEC, the unloading line would be filled with nitrogen and sealed. This would not interfere with other surface land uses.

At the onshore storage facility, storage tanks, and machinery would be dismantled and salvaged. Existing structures would be demolished unless some further use becomes feasible.

The nuisance impacts of noise, fugitive dust, visual disharmony, and traffic would create a temporary inconvenience during the abandonment process, but it should be of a smaller magnitude than during construction.

TRANSPORTATION AND UTILITY NETWORKS

Construction Phase

Traffic problems within the port of Skagway would be significant. During construction, barges at the proposed port site would extend up to 150 yards from shore. This would require cruise ships and cargo carriers to make a wider approach than presently.

Power for the proposed port and onshore storage facilities, including the construction workers camp, would be provided by NEC, and therefore would not exert loads on the existing services provided by Alaska Power and Telephone Co. Construction of distribution lines could cause some short term telephone outages in Skagway.

Telephone service for the work camp would place a heavy load on existing service. The system's present capacity would need to be increased to meet construction requirements. This is possible providing Alaska Power and Telephone Co. is given one year's notice.

The unloading pipeline would cross the existing RCA-ALA&CO cable at Second Street. When separate utilities cross, a risk of damage or personnel injury (electrical shock) exists.

Installation of new fuel tanks at the onshore facility would be scheduled to coincide with existing tank removal operations. Since temporary interruption of the CANOL pipeline would occur in the peak summer season of the second construction year, trucks would transport stored fuel to the Whitehorse and Yukon area when the CANOL line is inoperable.

It is estimated that the project would add a total of about 100 vehicles to the Skagway road network.

In addition to the work force, some project materials and equipment would be transported across town. The majority of the project-related trucking would be between the marine area and the work site. Momentary delays could occur while trucks unload along Second Avenue or along the Skagway-Carcross Highway. This same level of activity can be expected from the dismantling of some tanks at the existing onshore storage facility. Another source of increased traffic would come from the peak season shut-down of the White Pass & Yukon Route during construction. Substantial amounts of passengers and freight would shift to vehicular transportation. The combined increase in traffic from the work force, transportation of construction material, and railroad shutdown would cause temporary delays.

Operation Phase

During the operation phase, project-related traffic in Skagway and along the Skagway-Carcross highway would be insignificant. Permanent project and related employees are expected to be about 250 persons.

It is likely that air traffic to and from Skagway would increase as a result of operation. Passenger loads would increase for the existing commercial lines as facilities related personnel would travel to and from Skagway. In addition, air traffic in the vicinity would increase due to pipeline inspection flights and some additional private aircraft use. Increases would be small and should not cause air traffic problems.

Although no official capacity designation exists, the present traffic places no burden on the airport which is estimated to be sufficient for the next 20 years.

Normal operations would place no burden on the port of Skagway's berthing capacity, since a new unloading wharf is included. Bunkering would add to tanker traffic and congestion in the port with attendant fire, collision, and explosion risks. Between the cruise ship berth and the unloading wharf, additional berthing would be provided for the three tugboats needed to escort tankers to port. The movements of these tugboats would have only minor effects on port traffic.

Any major oil spill requires shutting down a harbor unless the spill is immediately contained. A minor spill could cause severe impacts depending on weather conditions. Cleanup measures would be aided by accelerated emulsification induced by the cold water in the port of Skagway. This procedure would keep the oil in concentrated areas and at the water surface. In the event of a fire and/or explosion, berthed cruise ships and ferries would suffer damages.

Abandonment Phase

During abandonment, only the facilities scheduled by NEC to be dismantled and salvaged would require transportation from Skagway. These impacts would be similar to the ones experienced during construction, but of a much shorter duration.

Utility networks, including electric, phone, and the CANOL line, would experience very minor impacts during the abandonment phase.

Any oil spills would have similar effects, given like size, as during the construction phase.

RECREATION

Construction Phase

Construction activities would have minor, short term effects on marine-related recreation.

Construction activities in and near the harbor will inconvenience and disrupt normal pedestrian and vehicular traffic. Additional inconvenience to recreationists would be caused by the construction activities: the port facility, a tug facility, the road access between the unloading area for construction material and the proposed port facility location, and the excavating, trenching, testing, and backfilling of the unloading line, particularly where it parallels the cruise ship wharf and traverses the terminal area from east to west. Peak construction activity would coincide with the summer tourist season.

Tourists would cross a portion of the construction area to get to recreational attractions in Skagway. Noise in the wharf area, especially from pile driving associated with the nearby tug facility, is likely to be the most intrusive impact on recreation, since cruise and ferry ship tourists use the ships as their hotel. Night construction noises and light would cause the most disturbance.

Construction of the onshore storage facility, and the location of the work camp south of it would have minor impacts on nearby recreational activities. Campers at the Liarsville campground, which is less than one-half mile from the existing facility would probably find construction noise and related activities annoying. If the proposed state campground across the Skagway River from the storage facility is in operation during construction, campers there would be subject to visual degradation and noise. Travelers on the Skagway-Carcross Highway would be similarly affected.

Operation Phase

An oil spill would cause the loss of fishing days, fouled boats and gear, and alterations of visual and aesthetic values. A spill during July, the peak month of the tourist season, could impair the recreational enjoyment of at least 50,000 tourists for an undetermined amount of time.

If a spill were extensive it would detract from recreational enjoyment during subsequent summer seasons and affect desirability of passage on cruise and ferry ships.

Impacts on recreational boating due to the presence of tankers should be relatively small.

Normal operation of the port and onshore storage facilities should not significantly impact recreational or tourist use of the Skagway harbor, However, summer cruise ships would be required to stop for at least one hour to allow tankers to properly align themselves for docking.

An oil spill in the harbor would reduce use of the area marine parks and campgrounds. Fishing, although limited in the harbor, would also be affected, particularly in the Taiya Inlet. Portions of the Chilkoot Trail could be aesthetically impacted. Less critical impacts on recreational users would result from a winter spill and affect negligible numbers of tourists.

Fire and explosion risk constitutes another potential impact on recreational resources in the vicinity of the port and onshore storage facilities. NEC states that risk analysis indicate that an explosion at the port facility would not affect the safety of people at the cruise ship wharf, but could cause structural damage. NEC's analysis could be subject to dispute. The radius of moderate damage could extend into the Skagway unit of the Klondike Gold Rush National Historical Park. An explosion or fire at the storage facility could impact recreational resources but would be highly variable according to the severity of the explosion or fire.

Abandonment Phase

Few impacts are anticipated to occur during the abandonemnt phase. Noise of heavy machinery in the area would affect recreationists in the same manner as previously described in the construction section. The marine terminal, however, could be converted to a berthing area for passenger ships.

ECONOMIC CONDITIONS

Economic section includes much of the inland sea leg and Alaska in general as well as the port area.

Construction Phase

Construction would influence economies beyond the immediate Skagway area. The community most affected would be Haines, with smaller impacts on Hoonah, Angoon, and other villages along Lynn Canal.

The demand for labor during the construction period would draw upon the regional labor pool, as well as require the importation of outside construction workers. Some local people employed during construction would be drawn from unemployment pool. Unemployment currently is acute in Haines.

Individuals from the other communities in southeast Alaska may seek jobs on the project. The effect on their communities and local labor forces would be less significant than the prospective shift of Haines workers.

In addition to the pool of unemployed workers, the pipeline project would draw people from existing jobs. The long hours and the opportunity to build up overtime pay would be prime attractions. Construction and service workers in both the public and private sectors would be likely to accept offers of construction jobs. Replacement of policemen, bank clerks, salesmen, and the local construction industry would be difficult particularly since the construction period (the time of greatest attrition) would be relatively short. People may be unwilling to accept the lower pay and the short-term nature of replacement jobs, when the attractions of the proposed NEC construction jobs still exist.

Should construction temporarily halt the railroad's passenger service, more ships may stop at Haines rather than at Skagway. Bus service may then be used for travel up the Alaska highway to the Yukon Territory, Canada, and its Kluane National Park. The shift of ships from Skagway to Haines may be temporary, since Skagway's historical character and the railroad excursion are not replaceable. Nonetheless, a cessation of rail traffic, even in the short term, could force new patterns of tourist activity. Once Haines becomes a stop for tourist vessels, and if the necessary services are put in place, tourism may become a significant factor in the Haines economy.

Should the White Pass & Yukon Route railroad service be cut back or halted even temporarily, the lead and zinc presently shipped from the Cyprus Anvil mine at Faro, Yukon Territory may have to be transported by truck down the Skagway-Carcross highway. If a full trucking operation were to be put into place temporarily to replace train operations, more jobs may be created in Skagway since trucking is more labor intensive than rail. However, should Cyprus Anvil decide to shift the entire transportation system away from Skagway as a result of the interruption of rail service, local jobs may be permanently lost.

Total income in Skagway and Alaska would be increased by the project. Project wages and fringe benefits during construction in Alaska would total about $3.19 million. Other wages which would be generated by local consumption expenditures and induced economic growth are estimated at $3.1 million for Skagway and $8.8 to $11.3 million for the rest of Alaska. These indirect income estimates for Skagway and Alaska are derived from the indirect employment impact estimates. Additional income would be generated by overhead and profit to Alaskan subcontractors and suppliers.

Real income gains would be partly offset by more rapid inflation. During the construction period, the distribution of income would be made more unequal in the Skagway area, both by the very high monthly earnings and by price inflation which would depress the real income of persons working in lower wage sectors or on fixed incomes. Public costs and revenues would not significantly affect income during construction.

In Skagway, public costs would initially rise somewhat more rapidly than revenues during the 2-year construction period. About $180 million would be added to the city's $30 million tax base, so future revenues would be assured and short-term bank credit should be available.

The city's present operating expenditures are $735 per capita for the 1978-1979 fiscal year budget. Some of the services provided are directly related to population size, so the operating cost of serving an additional inhabitant would be no higher, and probably less. The $375 per capita for new residents (exclusive of the construction camp) reflects no significant capital outlays. There appears to be sufficient school room capacity. For new houses or permanent mobile homes that would be installed during the construction period, water and sewage system improvements would be needed. NEC estimates $2,000 per lot for municipal utilities and system wide improvements would be needed. In all, the city cost should total about $815,000 during the construction phase.

NEC estimates city revenues would be expanded very little until project-related real and personal property would be added to the tax rolls. Taxes must be paid by the following September 1, after 20 months of the project. The net deficit up to that point is estimated at about $677,000 including an interest cost of roughly $86,000 assuming an 11 percent rate.

NEC estimates the first addition to the tax rolls at $72 million (40 percent of the completed cost of facilities within Skagway city limits) more than doubling the present total evaluation. Taxed at the 1978-79 rate of 10.5 mills, this addition would yield $727,000 paying off the 20-month extra cost, with interest, before construction was completed. The city's present debt limit of $9.8 million, less $1.1 million obligated, leaves borrowing capacity for the startup period.

State costs incurred during construction would include increases in revenue sharing allocations to Skagway after the first year due to population increase. Unit costs are estimates by the Alaska Division of Budget and Management, Office of the Governor. They are much higher than the total of $54.73 per capita budgeted by the city for 1978-1979, but may reflect higher allocations to other cities.

After construction is ended, some construction workers might remain, thus the demand for public assistance and family services would probably increase over preproject levels. Demands on private and institutional services would similarly increase.

Operation Phase

During the operation phase, 114 persons would be employed on the project and related work. The impact of these permanent workers would be relatively greater per employee than would be the case for transient construction workers.

The operations workers would spend a higher percentage of income locally and have more dependents. There would also be some permanent development of the local economy leaving a post-construction residual of other jobs.

NEC estimates the statewide population impact of the operation phase would be 661 to 1,169 additional persons.

The operation of the pipeline project would have little impact on the railroad. The increased number of ships utilizing the harbor facilities would mean more crowding and demand extreme caution in handling and maneuvering, but that should not affect the railroads's ongoing ore terminal, general freight, or passenger activities. The impacts on the tourist industry would be limited to the potential of more crowding at the port facilities whenever a tanker is in port. This should not diminish the numbers of tourists or ships coming to Skagway. The operation of the project would be a potential attraction to some tourists.

A major oil spill would, however, eliminate the tourist and railroad industries since the harbor would be closed down. If railroad passenger operations are resumed after the construction period, operation of the project would have no effect other than the visual intrusion and scarring which would continue from the construction stage. A similar impact would continue throughout the Klondike Gold Rush National Historical Park.

During operation, yearly wage income generated would include about $3.4 million to project and support workers (assuming $30,000 per worker and $15,000 per support worker), $2.1 million in Skagway, and $3.4 to $8.9 million in the rest of the state.

In the operation phase, the project would probably tend to have a levelling effect on the distribution of incomes. The non-seasonal aspects of the project would also stabilize the local economy.

In Skagway, municipal operating costs due to operation of the project would be those imposed by the added population. Assuming the present city average of $735 per capita, the impact would raise the budget by 52 percent, or $335,000. Additional capital costs would include the addition of two classrooms at about $3,000 each. An unquantifiable source of additional cost would be a general increase in standards of municipal service, both because of influence of urban newcomers from outside on community attitudes, and because of the greatly increased tax base.

The city's tax base included $34.2 million of real property and about $5.1 million of personal property as of January 1, 1979. The project alone would add about $200 million of taxable real and personal property within the city limits, raising the total from $39.3 million to about $240 million. If the budget were held to its present level per capita and there were no other revenue increases, the tax rate could be cut from 10.5 mills to less than 4 mills.

Other federal and state revenues, shared mostly on a population basis, now are budgeted by the city at $105 per capita.

The city revenue would be increased by about $50,000 due to the estimated additional population. Other revenues likely to increase due to the project include permits and licenses, boat moorage and sewage, and water and garbage fees.

State fiscal costs due to operation would include about $920,000 to $1.6 million in revenue sharing, plus the costs of oil spill protection and miscellaneous administration costs.

State revenue impacts would be dominated by royalty netbacks on the project. It will also receive income taxes of roughly $435,000 per year on project-related wages of about $5 million per year.

Abandonment Phase

Abandonment of the project would be expected to remove 114 operating and related jobs and 61 non-project jobs. Only slight out-migration should be expected of the remaining workers because of their long tenure in the community. Therefore, small overall population drops could be expected upon abandonment together with a significant increase in unemployment. There would be, however, a slight increased demand on public assistance programs and on private and institutional services.

Abandonment would have no significant effect on the railroad. It would mean increased capacity of the port to handle cruise ships, which may enable visitors to increase at a greater rate than during operation.

The impact of abandoning the project would be the immediate removal of about $3.4 million in yearly wages, and, if other growth sources do not evolve, a gradual decline of the induced income from secondary jobs.

The abandonment of the project would remove all the state and local revenue sources discussed above except for some taxes on residual induced economic activity. Population-related operating costs would decline more gradually as population adjustments are made.

SOCIAL CONDITIONS

Construction Phase

Housing impacts during construction would be severe. About one-half of the construction workforce would be housed in a company construction camp (NEC 1979), resulting in a demand for additional housing in Skagway for nearly 400 people during July of the second construction year. Because July is also the peak month for tourism, hotel and camping accommodations would be unavailable.

About 120 mobile home spaces would be required to meet peak demand if 80 permanent housing units are constructed by the second summer. Up to 228 spaces would be needed if no new permanent housing is built (NEC 1979). This would considerably alter the appearance of the city.

The water, sewage, and solid waste systems could not meet the increased demands. Construction impacts, therefore, would be adverse and significant. Although NEC proposes to provide such systems at the construction camp, new systems would be required for mobile home parks or new permanent housing.

The Skagway school system would not be adversely impacted because of the estimated 63-78 additional students (NEC 1979).

The current medical staff of Skagway cannot accommodate the needs of the construction workers. There would be a requirement for at least one nurse practitioner at the construction camp and at least one doctor.

Because of the number of workers at the peak of construction would more than double the current adult population, the city would need to double its present police force to maintain the current level of protection. The temporary jail facilities would be inadequate; another police vehicle would have to be purchased. Traffic and public disturbance instances would be prevalant.

Additional fire protection would be required at the construction camp and at the port facility. The City Manager has advised that funds would be lacking for both police and fire force increases. Construction phase impacts are considered to be critically adverse.

The Alaska State Ferry system would be benefically impacted during the construction phase of the project. Many construction workers would travel to and from Skagway by ferry and ship their automobiles and personal belongings by ferry. Overcrowding would not occur. Ferry passengers would experience a nuisance impact due to construction of the port facilities and ferry service could temporarily be slowed down or temporarily curtailed if an oil spill were to occur.

A slight decrease in tourism-related use of the air transportation system might occur because its use is closely tied to the railroad. However, construction related passenger and freight air traffic would result in a slight net increase to air traffic (NEC 1979).

During peak construction, population density of Skagway would more than double to 1,266 people per square mile with an average of 984 people per square mile. Residential housing conditions in the city would be crowded. The high proportion of single family dwellings would be reduced substantially. Residents would find it difficult to adjust to the effects of the rapid increase in population. Communities cannot readily adapt to any more than a 10 percent population increase per year (Gilmore 1975).

Employment characteristics and opportunities would be benefically affected during construction of the port and support facilities. It is estimated that the project would employ about 50-100 of Skagway's current residents (NEC 1979). The wages would be higher than those commonly paid in the tourist industry.

The Skagway government would be strained during the construction phase because of adverse impacts on the community infrastructure.

The construction phase of the project would have significant impacts on quality of life indicators in Skagway. The lifestyles during the winter months would become more formal and structured. Residents would experience more congestion in city streets and public facilities. Because of the large population increase, residents would have to compete for service in restaurants and bars and for goods in food and supply stores. They would no longer have the intimate, informal lifestyle of a small community; lifestyle during the summer tourist season would be minimumly impacted.

Wintertime recreation opportunities would be impacted because of the indoor nature of the activities. Basketball courts, theaters, and bowling lanes would be overcrowded. The community boat harbor would be crowded during summer months. Some pipeline construction workers would have small fishing boats, and compete with Skagway residents for the 200 mooring spaces under construction.

The perceived aesthetic setting of Skagway would be adversely impacted by the presence of up to 150 mobile homes in or near the city. The residents perceive the current aesthetic setting of Skagway to be historic and rustic. The city would not be as pleasing as "a place to live" as it was prior to the construction phase. The neighborhoods would become separated in terms of status. The workers living in mobile homes would be defined as newcomers or short-timers and be of a different status in the community than permanent residents. Values of the pipeline construction workers would differ from those of permanent, longtime residents. Because of this, the workers would not assimilate easily into the community.

Operation Phase

The company construction camp would not be maintained after the initial two-year construction period. Therefore, more than 150 permanent housing units would be required in Skagway. The scarcity of available building land in the area combined with very high building costs decrease prospects that this amount of permanent housing would be built over the next 20 years. This would require that some families continue to live in mobile homes.

New water and sewage systems, or renovation of the existing systems would be required to meet demands of 460 additional people (150 households) in the city.

The approximately 130 school-age children would increase enrollment to about 50 students over space capacity, resulting in some crowding of classrooms, and a reduction in the teacher/student ratio of 1:18.

Medical service requirements would remain the same as during the construction phase.

NEC estimates the current Skagway police force could accommodate needs during operation phase with the addition of one officer. The fire department could not cope with an oil fire at the port or along the pipeline route without additional staffing and equipment. A pumper boat at the port is required.

When railroad service is fully restored, project operation would have no adverse impacts on the railroad. The railroad would need to temporarily suspend service if a spill occurs. This could adversely impact tourism for a short period of time. A wintertime spill would cause greater impacts on local residents when the highway is closed.

The Alaska State Ferry System would continue to benefit from passenger usage by permanent project employees, but to a lesser extent than during construction. The risk and possible slow-down or suspended service impacts would be the same as during the construction phase. A spill during July, the peak month of the tourist season, would impair or suspend ferry transportation and recreational visits of tourists (NEC 1979).

Air traffic would increase. Passenger and freight loads would increase from project related operations. Air traffic in the vicinity would increase due to inspection flights and some additional private aircraft usage (NEC 1979). The airport is currently below estimated capacity, but conversion to an instrument-landing, controlled facility may be necessary.

The population density of Skagway would increase to 915 people per square mile during the operation phase. Residential housing conditions would be somewhat less crowded than during the construction period, but more crowded than currently. The high proportion of single family dwellings would be reduced substantially. The uniform character of the housing would no longer be present because of concentrations of mobile homes. Residents would continue to feel many of the adverse impacts of the construction phase during the operation phase because it would take several years to adjust to the changes in the lifestyle and quality of life.

Some permanent employment would continue to be available to Skagway residents and the slightly higher per capita income trend would continue. The city government would have adjusted to the strain brought about by construction phase of the project. The character of the government could change as current residents in government positions may be replaced by NEC employees. The government may become more bureaucratic and impersonal in adapting to these changes.

Residents of Skagway would gradually adjust to the changed lifestyle during the operation phase. A new lifestyle would be adopted and operations personnel would become members of the community. Impacts on the perceived aesthetic setting from the construction stage would continue to be present but most residents would gradually accept the altered setting. Residents would grow to again consider Skagway a comfortable "place to live" during the operation stage.

Abandonment Phase

Abandonment of the project would alleviate the demand for construction-related employment in the home building industry but would not be a severe impact due to the small size of the industry. Abandonment of the mobile home area would provide accommodations for many tourists. In addition, some permanent housing units would be available for summer employees and tourists.

Abandonment of the project would alleviate some of the water, sewage, and solid waste system demands. Some workers would remain in Skagway after the project. Abandonment would drop school enrollment below system capacity levels and lower the teacher/student ratio to around 1:11. Medical needs would continue at the same level after abandonment.

The abandonment stage of the project would result in a slight loss of revenue to the railroad but this impact would be minimal.

Abandonment of the port facility would create short term nuisance impacts on visitors coming by ferry.

Abandonment of the project would return air traffic in the Skagway area to near current levels.

The population density would drop below that of the operation phase, but remain slightly higher than the current density. The changed character of the housing in the city would remain after abandonment. Residents would have adapted to the pressures brought by the operation, but the social well-being in Skagway would not return to current conditions.

The quality of life would not be significantly impacted due to abandonment of the project. Employment opportunities for about 114 people would no longer be available, but many of these people would move to other cities or retire. The growing tourist industry would also provide some opportunities for people who wish to remain in Skagway.

PIPELINE SYSTEM

OIL SPILL, FIRE, AND EXPLOSION RISK ANALYSES

Oil Spill Risk

The basic statistical risk analysis techniques and the specific adaptations utilized to assess the risk of oil spills from onshore pipelines are presented in detail in a report by the Oceanographic Institute of Washington (1979a). The U.S. Coast Guard Pollution and Information Reporting System (PIRS) onshore pipeline spill data from 1973 to 1977 (Coast Guard 1978a) was used to provide information on onshore pipeline spills from all causes throughout the United States. Spills from all existing onshore pipelines were included in the analysis. It is to be expected, however, that newer pipelines will have lower risk rates than older pipelines so that the results presented here are considered to be conservative estimates of risk. Only spills of crude oil that were 2.4 barrels or larger were included; spills less than 2.4 barrels were excluded.

The exposure variable selected for the pipeline risk analysis was pipeline mileage. Usage of pipeline mileage as an exposure variable does not account for all factors contributing to the incidence of pipeline spills but does allow the best possible estimation of risk with available data.

Spill rates derived for crude oil onshore pipelines were applied to the existing pipelines in the greater Chatham Strait area and the proposed pipeline to estimate the frequency of spills. Statistical methods were use to provide an indication of the uncertainty of the calculated expected spill frequency values (wide variation in the historical number of pipeline spills caused the lower confidence limit to be undefined). Spill magnitudes were analyzed to identify the historical average spill size for pipeline spills 2.4 barrels or larger. To estimate the frequency of spills from the existing pipelines in the greater Chatham Strait area, the derived historical spill rate for onshore crude oil pipelines was used. It was assumed that pipeline spill frequencies were realtively independent of the type of material being transported. A preliminary examination of spills for product pipelines revealed a spill rate slightly higher than the rate derived for crude oil pieplines. Therfore, the spill frequencies estimated for the pipelines are probably slightly low.

The application of the derived historical onshore pipeline spill rate to the number of miles of existing pipeline in the area around Greater Chatham Strait yielded an estimated spill frequency of one spill in 21 years. This frequency represents the the expected occurrence of any spill greater than or equal to 2.4 barrels. (Expressions of probability are useful indicators of future events, but caution must be taken to avoid misinterpretation of these estimated values. One spill every 'X' years expresses a calculated rate and does not indicate when the spill may occur. Also, the estimate will remain valid only if conditions do not deviate significantly from historical patterns.)

A more comprehensive perspective may be obtained by assessing the spill frequency of different sizes of spills utilizing the cumulative probability of onshore pipeline spills. This allows the determination of frequencies for specific spill magnitude ranges for the existing pipelines in the area. The estimated overall spill frequency and the frequencies of spill magnitudes are shown in table 8.2.3-30, representing the existing oil spill risk associated with pipelines in the greater Chatham Strait area. A relatively small spill (2.4 - 10 barrels) is estimated to occur on an average of once in 58 years. Very large spills (10,001 - 100,000 barrels) are less frequent with an estimated spill in 7,100 years.

The expected frequency of spills from the proposed pipeline is also presented in table 8.2.3-29. This incremental spill frequency is estimated at one spill in 27 years to give a combined spill frequency for both the existing and proposed pipelines of one spill in 12 years. The estimated frequency of spill magnitudes is given in table 8.2.3-29. A small spill (2.4 - 10 barrels) from the pipeline could be expected once in 73 years to give a combined small spill frequency of one spill in 32 years. A very large spill (10,001 - 100,000 barrels) is estimated to occur only once in 8,900 years, giving a combined frequency for very large spills of one spill in 4,000 years.

TABLE 8.2.3-29 PIPELINE OIL SPILL MAGNITUDES
(Spills≥2.4 Barrels)

Spill Magnitude (barrels)	Estimated Spill Frequency and Uncertainty1/		
	Existing 2/ One spill in:	Incremental 3/ One spill in:	Combined 4/ One spill in:
2.4 - 10	58 years (28 - *)	73 years (35 - *)	32 years (15 - *)
10.1 - 100	45 years (21 - *)	56 years (27 - *)	25 years (12 - *)
101 - 1,000	170 years (82 - *)	210 years (100 - *)	95 years (46 - *)
1,001 - 10,000	820 years (390 - *)	1000 years (499 - *)	460 years (220 - *)
10,001-100,000	7,100 years (3400 - *)	8900 years (4300 - *)	4000 years (1900 - *)
A Spill≥2.4	21 years (10 - *)	27 years (13 - *)	11.9 years (6 - *)

Source: NEC 1979

1/ Ranges shown in parentheses are estimates of the uncertainty based on the 95 percent confidence limits derived from the historical spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all pipeline spills. Upper levels are not predictable, and are indicated by the asterisk (*).

2/ The existing spill frequency is estimated using the historical spill rate and the existing pipeline mileage in greater Chatham Strait.

3/ The incremental spill frequency is estimated using the historical spill rate and the proposed pipeline mileage.

4/ The combined spill frequency includes both existing and incremental spill frequencies.

The annual expected volume of oil spillage from pipelines was estimated for the existing pipelines around greater Chatham Strait and for the proposed pipeline route (see table 8.2.3-30). The existing baseline level of oil spillage from pipelines was estimated to be 29 barrels per year and the incremental spill volume due to the new crude oil pipeline was estimated to be 23 barrels per year.

TABLE 8.2.3-30 EXISTING AND INCREMENTAL

OIL SPILLAGE PER YEAR FROM PIPELINES

(Spills ≥ 2.4 Barrels)

	Volume of Oil Spilled Per Year (Barrels per Year)
Existing 1/	29
Incremental 2/	23
Combined 3/	52

Source: NEC 1979

1/ The existing volume of oil spilled per year is estimated using the historical spill rate and size, and the existing pipeline mileage in greater Chatham Strait.

2/ The incremental volume of oil spilled per year is estimated using the historical spill rate and size, and the proposed pipeline mileage.

3/ The combined volume of oil spilled per year includes both existing and incremental volumes.

The size of the worst spill was determined using the actual proposed pipeline parameters rather than historical data on large pipeline spills. A slow leak and a complete break in the pipeline were considered. In the first case, a slow leak in one of the four river-crossing sections is assumed. The block valves on either side of the leak are closed within 12 minutes but repairs are not completed until after that entire section of pipeline drains. In the latter case a complete break is assumed to occur in one of the river-crossing sections; the appropriate check valves are closed within 12 minutes. The amount of oil spilled is taken as the volume of that section plus the volume pumped out in the 12 minutes before the check valves are closed.

Results for both cases for the four river crossings are shown in table 8.2.3-31. The worst possible slow leak would occur in the fourth river-crossing section spilling 4,500 barrels of crude oil. A spill of this size would be expected to occur once in 1,000 years. The worst possible major break would be in the first river crossing section and would spill 12,000 barrels of oil. This size spill could be expected to occur once in 8,900 years.

There are three ways in which oil from a pipeline spill can reach a river environment. The oil can flow overland and eventually spill into the river, the oil can seep into the ground and reach the water table from which it will slowly move toward the area where the river, or the oil can spill directly into the river.

TABLE 8.2.3-31 SPILL MAGNITUDES AT WATER CROSSINGS

Section	Length (feet)	Diameter (inches)	Pumping Rate (barrels/hour)	Loss Due to Slow Leak (barrels)	Loss Due to Major Break (barrels)
First crossing	800	42	51,000	1,400	12,000
Second crossing	1,000	36	22,500	1,300	5,800
Third crossing	3,000	36	22,500	3,800	8,300
Fourth crossing	3,600	36	22,500	4,500	9,000

Source: NEC 1979

For pipeline spills in which the oil was discharged onto or into the ground, the oil would subsequently follow the path of least resistance. In uniformly permeable soils, the oil would be influenced by gravity and would travel in an essentially downward direction. In soils where the permeability varied, the oil would also flow ownward under the influence of gravity but might move laterally. When the oil reached the water table it would float on the top of this groundwater surface and begin to spread laterally as well as flow in the direction of the water table. Although oil has a tendency to adhere to soil particles and become immobile, the capability of the soil to immobilize oil may be exceeded and the oil would continue to migrate.

The rate of oil movement through the soil and along the water table is therefore dependent upon the size of the spill, the permeability of the soil, the slope of the water table, and the resulting rate of groundwater movement. If the spill from a pipeline were large enough, the soil may not be able to absorb all of the oil in a short period of time and the oil would flow over the ground surface. In addition a large quantity of oil spilled under pressure from a buried pipeline could also reach the ground surface if the soil became saturated, and subsequently flow over the surface.

Once oil entered the river environment, its movement would be a function of surface current velocity and direction of the wind. Additional factors which would influence the movement would be surface turbulence, suspended sediment load, and river morphology. Downstream bank contamination would depend upon the amount of oil and the channel configuration of the stream. When the spill volume was reduced to travel in major current areas or if the initial volume of oil was small compared to stream volume, bank deposition would be dependent upon river channel configuration.

Because of the steep slopes and the relatively thin covering of permeable soil between the pipeline and the river, any spill from this section of the pipeline would flow down the slope and into the river. Although the oil would seep into the permeable layer, a large spill would quickly saturate the thin layer of soil, and the lack of any significant groundwater would preclude the slow seepage of oil into the river by this mechanism. In addition, during the winter months the frozen ground would prevent any significant seepage into the soil. Vegetation could serve to retard the flow of oil down the slope.

The compilation of the minimum detectable spill and the maximum spill from the pipeline at the four principal pipeline river crossings are included in table 8.2.3-31. The pipeline crossing at the junction of the Skagway river and White Pass Fork could spill 4,500 barrels for the minimum detectable spill and 9,000 barrels for the maximum spill. The pipeline crossing over the East Fork of the Skagway River could spill 3,800 barrels for the minimum detectable spill and 8,300 barrels for the maximum spill. The two pipeline crossings at the onshore storage facility could spill 1,300 and 1,400 barrels for the minimum detectable leak and 5,800 and 12,000 barrels for the maximum spill. It has been assumed that for a pipeline spill the section of pipeline between the check valves located on each side of the river will be shut down completely in 12 minutes. The spill rates for the maximum spill at the pipeline river crossing at White Pass Fork, East Fork, and the two crossings at the tank farm are 70.2 cubic feet per second (cfs), 64.7 cfs, 45.2 cfs, and 93.6 cfs respectively. Because the average discharge for the Skagway river is 509 cfs, the oil spill rate during the 12-minute period ranges from 9 to 18 percent of the average river discharge. These percentages are applicable only for the two pipeline crossings at the onshore storage facility. Percentages will be higher at the upstream crossings because the total discharge of the Skagway should decrease with distance upstream.

The river system which runs alongside the proposed pipeline route can essentially be divided into three primary sections; White Pass Fork where the slope of the river is 300 to 400 feet per mile with resulting high water velocity and a streambed of stones and boulders; the Skagway River between White Pass Fork and the East Fork where the gradient is approximately 150 to 200 feet per mile with lesser water velocities but a comparable streambed composition; and the Skagway River from the East Fork to the river mouth at Skagway where the river gradient is 25 to 75 feet per mile with lower water velocities and a streambed composition ranging from cobbles and gravel to sand. Here there are numerous braided streams interspersed with alluvial deposits.

Although none of the four major pipeline crossings occur in the White Pass section, there is a buried pipeline crossing on the East Fork of the White Pass Fork and a spill here would reach White Pass Fork. In times of low to moderate flow conditions there would be numerous back-eddies and pools where oil would become trapped. In addition, the narrow channel would guarantee the inundation of both river banks from a large spill. In times of low to mean flow conditions, a maximum pipeline spill could contribute a volume of oil equal to approximately 25 to 50 percent of the stream flow during the 12-minute shutdown time. Winter icing and snow cover on the river would also provide areas where the oil could concentrate. In times of extremely high flow conditions, the quiet pools and back-eddies would tend to disappear as the water covered all but the largest boulders. During this time, the oil would tend to be carried downstream more readily but the extremely high turbulence would mix the oil to the streambed. This turbulent mixing and break-up would also be present during all but the lowest flow conditions.

Two of the four major pipeline river crossings occur within the White Pass Fork to East Fork section. Although the river gradient is less than in White Pass Fork, the relatively high water velocity, turbulence, and the stones and boulders in the streambed would again cause pools and back-eddies during all but the highest flow conditions and would result in significant mixing and oil breakup. The inside of bends in the river channel would provide areas where the oil would tend to collect. As before, the relative narrowness of the channel would result in both riverbanks being impacted from a large volume spill, which may contribute oil at a rate of approximately 15 percent to 25 percent of the river discharge during low to mean flow conditions.

Downstream of the Skagway River-East Fork junction, the Skagway River divides into numerous smaller streams separated by alluvial deposits of cobble, gravel, and sand. In addition, the valley floor widens and provides an area for groundwater to collect. The meandering nature of the streams and the exposed sediments provide numerous areas for deposition of oil. Three of the four major pipeline crossings in this area; the one located on the East Fork, and the two buried crossings near the onshore storage facility could contribute oil from a large spill at rate of approximately 10 to 20 percent of the stream discharge during low to mean flow conditions. The buried pipelines may also contribute oil to the groundwater where it may migrate to areas under the town of Skagway. The decreased river gradient and the finer composition of the streambed result in a decreased level of turbulence and therefore less mixing; however, the gradient is still steep enough to generate high velocity, turbulent flow during mean to high flow conditions. In this case there will be a significant amount of mixing and oil breakup.

The possibility of a pipeline oil spill into Summit Lake, which feeds White Pass Fork, should be considered. The small dimensions of the lake mean that an oil spill from the pipeline making its way into the lake could spread to the entire shoreline as it moved slowly to the White Pass Fork inflow area.

Pipeline Station Fire and Explosion

The frequency and damage of fires and explosions which could occur at the main line pump station of the proposed oil transhipment system and the existing station of the White CANOL petroleum products pipeline are estimated based on historical data (NEC 1979).

To assess the historical pipeline station fire and explosion rate, fires resulting in damages over $1,000 which were reported in the American Petroleum Institute's Reported Fire Losses in the Petroleum Industry (American Petroleum Institute 1972-1976) from 1972 through 1976 were evaluated.

The frequency used by API was fires per 100 properties. Explosions were not reported separately, so the following analysis for fires does not provide information on pump station explosion rates.

Using standard statistical procedures, the API fire loss data was analyzed to estimate the fire frequency and the associated uncertainty for the present pump station and the proposed pump station. It is assumed that the sites of these stations do not have inherent geological hazards. The estimated existing, incremental, and combined frequency of fires due to the CANOL and proposed pump stations is presented in table 8.2.3-32.

Although the fire frequencies present an overall view of the fire risk, they do not address the actual amount of damage that might occur. To calculate the expected damage size distributions for the proposed pipeline stations, the historical API fire loss sizes were analyzed. Combining the fire frequency estimates given in table 8.2.3-32 with this information on damage size distribution, the expected incremental damage estimates for the proposed pump station were calculated and are given in table 8.2.3-33. For example, a fire causing over $500,000 damage would be estimated to occur about once in 14,000 years.

All of the historical fires reported in the API fire loss data originated on the pipeline station property and less than 8 percent spread to surrounding property. Historical information on fatalities (API 1973-1976) for fires and explosions in the petroleum industry as a whole, not just for pipeline stations were analyzed. Information on fatalities specific to pipeline stations was not available. The mean frequency of employee fatality due to fires or explosions was one death each year by fire or explosion for every 43,000 employees. The proposed NEC system would employ about 60 people at the onshore storage facility and pipeline station at Skagway. The estimated frequency of employee fatality due to pump station fires or explosions would be one death in 700 years.

TABLE 8.2.3-32 PUMP STATION FIRE FREQUENCY

	Estimated Fire Frequency and Uncertainty 1/ One fire in:
Existing 2/	270 years (180 - 500)
Incremental 3/	270 years (180 - 500)
Combined 4/	130 years (90 - 250)

Source: NEC 1979

1/ The ranges shown in parenthesis are estimates of the uncertainty based on the 95% confidence limits derived from the historical fire rate.

2/ The existing fire frequency is estimated, using the historical fire rate and the existing pipeline stations in greater Chatham Strait.

3/ The incremental fire frequency is estimated using the historical fire rate and the proposed pipeline station at Skagway.

4/ The combined fire frequency includes both the existing and the incremental fire frequencies.

The consequences of possible pump station explosions were modeled in a manner similar to tanker explosions. The models and assumptions are described in detail in a report by Oceanographic Institute of Washington (1979a). For the models it was assumed that one pipeline station building containing an ideal mixture of fuel and air exploded with total detonation. This a conservative assumption leading to higher estimates of damage than would actually be expected to occur from an explosion. The type and extent of damage from this pump station explosion are presented in table 8.2.3-34. For the modeled pump station explosion, people within a radius of 270 feet could be killed, while people beyond 370 feet would be mostly safe from injuries.

Depending on the location of the station, people at the facility buildings or along the lower access roads could be injured. There would be scattered window breakage in Skagway, with no moderate or severe damage outside the boundary of the facility.

TABLE 8.2.3-33 ESTIMATES OF FREQUENCIES OF FIRE DAMAGE MAGNITUDE FOR THE PROPOSED PUMP STATION (Losses ≥ $1000)

Fire Loss Magnitude $	Fire Frequency and Uncertainty 1/
1,000 - 10,000	510 years (340 - 940)
10,000 - 100,000	840 years (560 - 1,600)
100,000 - 500,000	2,100 years (1,400 - 3,800)
500,000	(14,000 years (9,000 - 25,000)
1,000	270 years (180 - 500)

Source: NEC 1979

1/ The ranges shown in parenthesis are estimates of the uncertainty based on the 95% confidence limits derived from the historical fire rate.

TABLE 8.2.3-34 POSSIBLE PUMP STATION EXPLOSION CONSEQUENCES

Type of Damage	Radial Distance (feet)
Human Casualties:	
Mostly safe	370
Lethality threshold	270
Lethality near 50% probability	250
Lethality near 100% probability	230
Structural Damage:	
Wood Frame	
Scattered	1,550
Moderate	800
Severe	600
Brick, Multistory	
Scattered	1,550
Moderate	700
Severe	500
Light Steel Frame Industrial	
Scattered	1,550
Moderate	220
Severe	150

Source: NEC 1979

AIR QUALITY

Construction Phase

Particulate emissions during the construction of the proposed pipeline would result from construction equipment, blasting and earth moving, concrete mixing, and rock crushing activities. Estimates of these emissions are difficult and subjective. Exact emission rates of the fugitive dust are dependent upon factors such as the type of soil, moisture content of the soil, and wind speed. Impacts would be confined to the immediate vicinity of the site and would be of limited duration.

The types of emissions and impacts would be similar to those found during construction of the port and onshore facilities. Any impacts these emissions would have on the air quality along the pipeline route would be of short duration.

Operation Phase

Emissions from the proposed pipeline would be negligible during the operation of the pipeline and no significant air quality impacts would be expected.

Abandonment Phase

If the pipeline is not removed there would be little effect on air quality.

NOISE

Construction Phase

While there are no residences, schools, hospitals, or other noise sensitive receptors along the proposed pipeline route, a large portion of this route would be within, or border, the White Pass Unit of the Klondike Gold Rush National Historical Park. Noise during the construction phase would disrupt recreational activities in the park. At an estimated 40 to 50 dBA, it would be an annoyance to most people and wildlife.

In addition, tourists using the Skagway-Carcross highway may be annoyed by construction noise. Blasting noise levels at the highway would be noticeable.

Operation Phase

The operation of the pipeline would have no impact on noise in the vicinity of the pipeline except for occasional maintenance or repair operations.

Abandonment Phase

Abandonment of the pipeline would have no noise impacts unless the pipeline were removed, in which case impacts would be similar to those during construction.

TOPOGRAPHY AND GEOLOGY

Construction Phase

Existing slopes along the pipeline corridor vary from level to 100 percent with an average of approximately 60 percent over most of its length. When considering the amount of excavation required, the slope of the backwall would be 150 percent, either terraced or angled back from the floor of the cut.

Along steeper portions of the route up to approximately 1.2 million cubic yards per mile would be excavated to produce a working surface of 90-feet wide. A trench for the pipeline (and a small existing pipeline) excavated on this surface would require removal of an additional 11,000 cubic yards per mile. An approximate average volume per mile to be excavated over the length of the route, assuming an average existing roadbed width of 15 feet and an average slope perpendicular to the right-of-way of 60 percent, would be 440,000 cubic yards.

The railroad passes through two tunnels in bedrock and one snowshed. Enlargement of the tunnels would require excavation of additional rock. The snowshed would also be enlarged.

The pipeline project would produce up to 6 million cubic yards of broken rock and other excavated material. Disposal of the unused portion of this material would produce a topographic impact unless distributed over a large area. Fills along the route, e.g. over numerous small watercourses, would also constitute impacts on topography.

The excavation itself would constitute a major impact on topography with a backwall height of up to approximately 140 feet in steeper places and an average backwall up to approximately 50 feet in height. Unless proper care was taken, rockfall could be severe.

This cut would accumulate large quantities of drifting snow in winter adding to snow removal requirements and snowslide hazards and prolonging the drying period in the spring. Construction would affect the gradient of some streams in the vicinity of crossings.

Operation and Abandonment Phases

Topographic impacts during these phases would be minor.

The 36-inch pipeline from the storage facility to White Pass would be designed in accordance with the requirements for zone 3.

In areas where the pipeline is buried in bedrock, ground shaking would not be expected to rupture it. Where the pipeline would traverse thick deposits of alluvium, severe shaking may rupture the pipe and damage block valve installations.

Significant differential settlement may be expected where the pipeline would cross thicker alluvial deposits in the Skagway valley.

Where the pipeline route would cross exposed or thinly mantled fault lines, the potential exists for rupture in the event of displacement along the fault. If this occurred near the lineament immediately north of the East Fork crossing, as much as

12,000 barrels of oil could be released into the Skagway River drainage in spite of block valve closure. Ruptures in other locations along the route would cause loss of smaller volumes, provided valves were promptly closed, because shorter segments between valves would be involved.

The potential for landslides, rockslides, and rockfall would be increased along the more precipitous parts of the route by enlargement of the cut in the colluvial and bedrock slopes which would produce a high, steep backslope in many locations. These processes may lead to hazards or increased maintenance requirements in the operation of the Yukon and White Pass Route and the associated telephone line. The large cuts would continue to have an effect on mass movements long after the abandonment phase, affecting whatever future use the area may have.

SOILS

Construction Phase

The excavation, required for right-of-way widening and water crossings, would devegetate and alter about 135 acres of soil area. This would increase the potential for wind and water erosion from both surface runoff and undercutting at river and stream crossings. Quantification of the potential soil loss is not possible due to lack of data. A small loss in terms of tons of soil per acre on these very shallow soils would have a relatively large impact. Natural replacement could take hundreds of years.

Operation Phase

Revegetation of soil-disturbed areas would stabilize erosion at preconstruction rates. Slight, undeterminable losses would occur as a consequence of periodic use of access roads.

A potential impact of pipeline operation would be soil contamination and subsequent loss of productivity due to terrestrial oil spills. Although recent research indicates that prespill conditions can be reestablished in 5 to 10 years under some conditions, reclamation would probably take longer within this route segment. The relatively short, cool summers along with an abundance of cloudiness and snow, would retard biodegradation of oil particles in the soil. Greatest impacts would occur in the deeper alluvial soils of the valleys.

Abandonment Phase

If the pipeline system and other facilities were left intact and the pipeline were filled with inert material, impacts would be negligible.

AQUATIC RESOURCES

Physical ComponentS

Construction Phase

Although only four major buried stream crossings would occur between Skagway and White Pass, the pipeline route would closely parallel the Skagway River, including White Pass Fork. Alterations to the vegetative cover, along with the earthwork, blasting, and grading, could lead to degradation of the water quality due to increased water temperatures and suspended sediment. Earth and rock from the blasting and grading could contribute to the sediment load. This could be a long-term impact. The effect of heavy metal concentrations in the streambed is not known.

Any impact on groundwater level and movement would be expected to be insignificant and would not affect use.

Burial of the pipeline under the river would result in temporary diversion of the river and a relatively temporary increase in sediment load.

The impact of hydrostatic test water used in the pipeline would be similar to that used in the onshore storage facilities.

Operation Phase

The operation of the pipeline would have very little impact on the aquatic environment unless an oil spill occurs. If a spill does occur there may be significant pollution of groundwater, streams, and the Skagway river. Spilled oil could be transported by the Skagway river to Taiya Inlet and affect the marine environment. The magnitude of the impact of such a spill would be determined by the frequency, location, size, how soon and how effectively it was cleaned up, and season and weather conditions at the time of the occurrence. A large spill would contaminate the aquifer which supplies Skagway.

Abandonment Phase

If the pipeline is left in place, and the residual oil is flushed from it prior to abandonment, no oil-related impact other than from the disposal of the flushing water would occur. The disposal of the flushing water, if discharged slowly into the Skagway river, would have much the same impact as the oil-contaminated runoff.

Biological Components

Construction Phase

Construction of the pipeline system would impact fish, insect, and benthic invertebrate populations. Vegetation removal would reduce fish escape and resting cover, decrease the quantity of terrestrial insects falling into the stream, and increase local water temperature. In addition, erosion from the exposed bank could result in an adverse impact by causing sedimentation downstream. The extent of this impact would be affected by amount of rainfall, soil type, percent and length of slope, runoff patterns, extent of vegetation removal, and time required for revegetation.

The sediment could smother fish eggs, insect eggs, and larvae and would probably remain until the next period of high stream flow. The initial sediment deposition could impact areas within several hundred feet of the pipeline crossing while the sediment dislodged during high runoff flow would impact fish and insects further downstream but to a lesser extent than the initial deposition.

The loss of fish or insects due to erosion should not have a major effect on fish and insect populations in the river. If there is a concentrated fish spawning area

immediately downstream of the crossing, the impact would be much greater possibly taking many years to recover to pre-construction levels.

Downstream deposition of sediments would occur during instream trenching as sediments were disturbed. Actual deposition would coincide with periods of instream construction and would extend over a period of a few days. The heaviest sediment deposition would extend immediately downstream from the crossing for several hundred feet and would remain for an indefinite period of time depending on particle size and water velocity. The impact would be as described above for sedimentation from erosion.

Location of the pipeline within the railroad right-of-way above the river could have an adverse impact on fish spawning areas, insects, and aquatic vegetation if rock blasted from the mountainsides should fall into the river. Spawning beds and insect production areas could be destroyed, aquatic plants would be crushed and the substrate destroyed.

Finally, the rock could serve as a barrier to anadromous fish migrations.

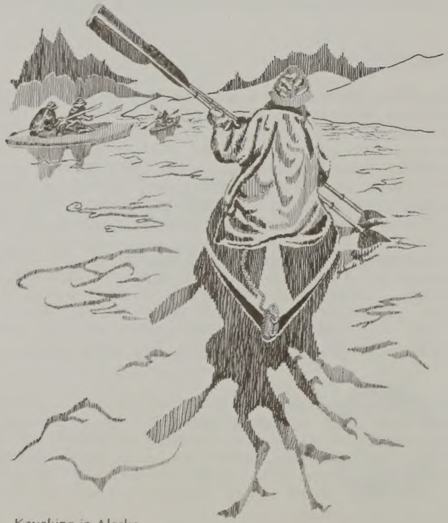
Hydrostatic testing of the pipeline could result in mortalities to fish and insects entrained in the pipe during water withdrawal. The number of organisms thus affected would be small unless water withdrawal occurred during anadromous fish migrations. Insects and fish eggs may be dislodged from the stream bottom by test water discharge. Also, the possibility exists that toxic metals may be leached from the pipe and have a short term toxic effect on fish and insect populations.

Operation Phase

A pipeline rupture or leak releasing crude oil into streams could occur during the operation phase. In most cases an oil spill along the pipeline route would likely reach marine waters at Skagway. Turbulence within the stream would cause the oil and water to mix and contact virtually all downstream areas below the waterline including spawning gravels along the stream bottom. Once stopped, the flushing action within a stream would replace oil contaminated water with clean water. However, oil adhering to rocks and incorporated into sediments and spawning gravel would remain and continue to release residues for months.

The severity of impact would depend on the volume of oil spilled, stream flow, species and life history stage exposed, exposure time, and containment and cleanup efforts. Large spills and spills extending over a long time could reduce salmon and trout populations significantly. Impacts could range from complete elimination of all fish and insects downstream from the spill for large spills and exposure times, to no detectable impact for small spill volumes and short exposure times.

Oil could cause mortalities to fish by interfering with respiration, direct toxicity, destroying eggs or newly hatched fish in the gravel, and by deoxygenating water and suffocating fish. Oil could also narcotize or stun fish causing greater vulnerability to predation, interfere with nasal and other sensory receptors, and taint fish. Oil could also cause mortalities to insects through toxic or smothering actions which would reduce the food supply for fish and possibly reduce their growth and survival rates.



Kayaking in Alaska

Sedimentation could continue during the operation phase depending on the rate and success of revegetation at crossing sites. Areas with steep slopes, unstable soils, and high runoff would be difficult to revegetate and erosion could continue at these sites for several years. Impacts would be similar to those discussed for sedimentation in the construction phase.

Abandonment Phase

If the pipeline were drained of oil and capped, no significant impact would occur.

MARINE RESOURCES

Biological Components

Construction Phase

There are no anticipated significant impacts to the biological components of the marine ecosystem associated with construction of the pipeline system.

Operation Phase

There could be impacts to marine resources during the operation of the pipeline if a spill occurred. A pipeline spill near the Skagway river would have major impacts on salmon fisheries of the area, and could be transported downstream into Lynn Canal. Impacts to marine resources, with the above exception to salmon, would only be moderate to minor. See 8.2.3 Marine Resources section for discussions of the effects of oil spills on the marine environment.

Abandonment Phase

There would be insignificant impacts if the pipeline would be cleared of oil and left in place.

TERRESTRIAL VEGETATION

Construction Phase

Impacts resulting from the installation of a pipeline would be similar to those identified for the construction of the pipe stockpiling and onshore storage facilities.

The total amount of vegetation which will be cleared for construction of the corridor is uncertain at this time (see table 8.2.3-35). Only after specific locations are known and required plant surveys made, will any threatened or endangered species be located.

At the present time, only an estimate of acreage can be given. The minimum amount necessary, assuming flat terrain, is 135 acres. Using an average slope of 100%, the maximum clearing necessary would be 300 acres. The true figure is probably closer to the latter, since most of the corridor follows extremely steep slopes.

TABLE 8.2.3-35 MINIMUM ACRES OF VEGETATION TO BE CLEARED ALONG PIPELINE

		Pipeline Corridor Adjacent to Existing Right-of-Way		Pipeline Corridor Not Along Existing Right-of-Way		Totals	
Pipeline Mile	Vegetation Type	Miles	Acres To Be Cleared1/	Miles	Acres To Be Cleared2/	Miles	Acres To Be Cleared
0 to 2.8	Riparian	1.8	16.75	1.0	11.17	2.8	27.92
2.8 to 10	Western, Hemlock/Sitka spruce forest	5.7	53.04	1.5	16.75	7.2	69.79
10 to 10.5	Subalpine	0.5	4.65			0.5	4.65
10.5 to 14	Alpine	3.5	32.57			3.5	32.57
Total of Columns		11.5	107.01	2.5	27.92	14.0	134.93

1/ Assuming a 75-foot corridor to be cleared and a 15 foot existing right-of-way over flat terrain.

2/ Assuming a 90-foot corridor for construction purposes over flat terrain.

Approximately half of the corridor passes through the western hemlock-Sitka spruce zone, where low grade marketable timber is found. The intrinsic value of this timber would be realized. The remainder of the corridor passes through areas that are treeless or occupied by deciduous tree species. Some trees would be sold locally as firewood while the remaining slash would be burned or mechanically chipped and used as a mulch.

The primary impacts of the proposed pipeline on the forest, riparian, and alpine areas would be the removal of all of the vegetation along the pipeline right-of-way. Loss of plant cover would result in:

- an alteration of wildlife habitats and food sources;
- a loss of ground cover, which would result in increased soil erosion and instability;
- a loss of aesthetic values; and
- a loss of timber potential for the life of the project.

Operation Phase

Major impacts associated with the operation of the pipeline system include: continued removal of large woody vegetation from the corridor and an oil spill due to a break or leak in the pipe that would affect vegetative growth downhill from the rupture.

In order that maintenance and monitoring operations may be carried out swiftly and thoroughly, the pipeline corridor will be maintained free of vegetation through manual clearing and use of herbicides. If herbicides are used, it is likely that wind and water will carry the chemicals to areas surrounding the corridor, thereby increasing the area of disturbance. Continued removal of vegetation will decrease the availability of wildlife habitat.

In the event of a slow leak being undetected or a catastrophic break in the line estimates of oil spill range from 4,500 to 12,000 barrels. These estimates are based on a break in the line at the fourth river crossing at approximately pipeline mile 10; an oil spill in this area would flow down the river and into Taiya Inlet. There would be damage to vegetation along the river and delta and to the coastal beach community of the inlet area. An estimate of acres which would be lost is unavailable.

In addition, potential for further damage exists during cleanup operations. Whether or not the spill is cleaned up, further major impacts to the environment would occur.

Abandonment Phase

Abandonment procedures proposed by NEC call for leaving the pipeline in place and filling it with an inert material. Under these conditions, no further destruction of vegetation would occur. However, due to compaction of the soil during construction, maintenance, and monitoring operations, revegetation of the area may be hindered. In addition, surface and subsurface drainage and soil profiles will have been altered. All these factors will make reclamation procedures difficult.

Because of the large cut to be made in the hillside for pipeline installation, reclamation of the area can be cosmetic at best. The backwall of the pipeline corridor, due to steepness and lack of soil, will not revegetate in the forseeable future. Taking these factors into consideration, the scar from the pipeline trench will be a visible part of the environment for many years after abandonment. Steep cliffs will be an ever present danger to wildlife and visitors to the area.

TERRESTRIAL WILDLIFE

Construction Phase

Construction activity including blasting through the lower portion of the Skagway river floodplain would influence an already disturbed area. Since the floodplain is a diminishing habitat for wildlife, removal of select areas utilized as part of feeding and hunting ranges could completely reduce remnant populations of muskrat, weasel, and waterfowl. Species dependent upon brushy and wooded areas not far from water may also be displaced or reduced. Species using the river as an

Raccoon

access to other areas would be forced to alter hunting, migration, or other movement along their river access routes.

Construction of the pipeline along the upper floodplain of the river would impact feeding and watering areas used by: beaver, muskrat, mink, river otter, and marten. Impacts would also include removal of burrows, denning sites, and escape cover. Alteration of shrub species, low growing herbaceous vegetation, and aquatic vegetation, would modify availability of rodent, amphibian, and invertebrate prey.

Removal of willow, alder, and associated vegetation along the floodplain would remove moose habitat used by a remnant herd along the upper Skagway River. Reduction of adjacent timber stands would reduce thermal winter cover for moose and winter habitat for mountain goats and blue grouse.

Construction activities through the western hemlock-Sitka spruce vegetative type would reduce the availability of seasonal food sources and use of travel routes for mountain goats, black and brown bear, moose, coyote, and wolverine. Construction in undisturbed areas with good cover and abundant herb and shrub understory would be particularly detrimental. Removal of tall shrubs and herbaceous plants along the timberline would reduce habitat for willow and rock ptarmigan.

Construction in alpine tundra could impact food sources as well as escape and thermal cover used by ptarmigan, hoary marmot, ermine, red fox, and lemmings. Hunting habits, travel routes, and interrelationships within a species could be impacted by construction. The degree of influence would depend upon the season and duration of disturbance, degree of soil disturbance, avoidance behaviors developed by prey, and individual tolerance levels. Removal of vegetation types with low growth vegetation and open spaces would reduce habitat for wide ranging species dependent upon seasonal fruits and herbs, such as the brown bear.

Figure 8.2.3-1 depicts periods during the year when various wildlife would be most impacted by blasting and other construction activities.

Operation Phase

Impacts on wildlife resources from pipeline operations would be minimal except in the event of an oil spill, fire, or explosion. An oil spill would have the greatest impact on wildlife near stream crossings and along the floodplain. Species using riparian feeding and watering areas would be most vulnerable. Alteration of wildlife composition would depend on the size and time of the spill, degree of cleanup, and amount of damage to soil, water, and vegetation.

Abandonment Phase

Impacts to terrestrial wildlife will depend upon the procedures employed during the abandonment phase. Species dependent upon the ecotone created during the pipeline operation could be altered or displaced as vegetation matures. Only those wildlife which are tolerant of the early stages of vegetation along the right-of-way would benefit. Long term impacts may include the permanent alteration of wildlife habitat.

CULTURAL RESOURCES

Construction Phase

Rock fall from pipeline construction blasting activity could cover existing evidence of vegetative indicators of the Brackett Wagon Road making future location more difficult.

In crossing directly from mile 5 to mile 7 on the railroad, the pipeline could affect several portions of the Brackett Wagon Road.

From Rocky Point northward the White Pass trail and the camps along the trail could be adversely affected by a rock-fall or slides from pipeline construction.

The stops at Clifton, Viaduct or Denver Station, Glacier, Inspiration Point, Dead Horse Gulch, the Steel Bridge and Summit are all historic points. The register status of the Clifton and Viaduct (Denver) stations is uncertain in terms of their eligibility, but Glacier station is on the Alaska Heritage Resource Survey list, and the remainder are in the White Pass Historic District. Construction of the pipeline would degrade these historic sites.

No paleontological sites were discovered in the area surveyed for the pipeline system.

Operation Phase

As in the construction phase, operations involving movements of personnel, equipment, and supplies for maintenance and oil spill cleanup would further degrade resources in close proximity to the pipeline.

Oil spills would have an immediate impact on sites in the vicinity and could create secondary effects where streams would carry oil to downstream locations. Fires and explosions could destroy the sites.

Abandonment Phase

Since NEC proposes to leave the pipeline in place, only minor impacts to cultural resources would be anticipated.

VISUAL RESOURCES

Construction Phase

Clearing of the pipeline right-of-way requires removal of existing vegetation and exposure of the soil or blasting of rock--either alternative would have high visual impact. Even with revegetation, there would be moderate color and texture contrast with the surrounding forest that would persist far beyond the life of the project. Revegetation would be extremely difficult, so the contrast of the exposed soil and bare rock sloped to the adjacent undisturbed vegetation would persist. In less scenic and in more developed areas the visual contrast would be less noticeable. The large cuts and shear rock faces would be seen as permanent adverse visual impacts.

Operation Phase

Pipeline valves (which would be partly buried but extend 5 to 6 feet above ground) would have a significant adverse visual impact on the stream crossings. If a major oil spill should occur, this would cause significant adverse visual impacts on the right-of-way and lower rock faces. Skagway River would be contaminated, resulting in water discoloration and shoreline, harbor, and inlet visual pollution. Cleanup operations of oil spills could have more extensive visual impacts than the construction phase. Fire and explosion impacts would be dependent on the size of the fire or explosion.

To viewers from the railroad and Skagway-Carcross highway, these visual impacts would be disturbing.

The massive shear rock faces that would result from cutting the right-of-way into steep slopes of bedrock would constitute critical adverse visual impacts for train passengers, highway travelers, park visitors, and residential viewers. The view of the pipeline from the highway would be similar to the present view of the new highway construction.

Abandonment Phase

If the pipeline is left in place, visual impacts would continue.

LAND USE

Construction Phase

Approximately 135 acres of land would be disturbed by construction of the pipeline and its related facilities. There would be no significant effect on industrial or urban land use along the pipeline since there are none. No rangeland or agricultural land has been identified within the pipeline corridor.

Construction would result in the loss of forest in the southern and middle sections of the pipeline route. This forest land lies within the Tongass National Forest and the Klondike Goldrush National Historic Park and has been designated as land to be maintained in a roadless state. The total amount of forested land lost would be approximately 70 acres; the land is not valuable for commercial timber. It would take three to five years to re-establish vegetation sufficiently to stablize slopes.

One native claim area (pipeline mile 3.5) in close proximity to the pipeline may be affected. It lies above the pipeline route in an area of steep mountain slopes.

There are no known natural or scientific areas within the proposed pipeline corridor.

Construction activities would have a significant impact on the Klondike Gold Rush National Historical Park. The effects would be associated with widening the existing railroad right-of-way. The resulting rock cuts, with associated devegetation and possible deposition of rock and debris on lower slopes, may significantly decrease the visual, wilderness, and historical values of the park.

Except as described above, the pipeline system facilities would not tend to seriously constrain land-use plans and zoning.

Operation Phase

Pipeline operation would have few impacts on land use; these would be related to maintenance operations for the most part.

Urban and industrial land should not be affected by the pipeline. In the case of a pipeline failure the impact on industrial and urban areas along the pipeline route would not be high and would be limited to oil pollution in the river.

Forest land that would be impacted during the construction phase would continue to be impacted during the operation phase.

The native claim area should not be affected significantly by normal operation of the pipeline.

Operational effects on the Klondike Gold Rush National Historical Park should not be significant since most impacts would have occurred during the construction phase. An oil leak, depending on its size and location, may significantly affect the park.

In general, pipeline system facilities would not tend to seriously constrain land-use plans and zoning.

Abandonment Phase

When abandoned, the underground pipe would be filled with inert material, sealed, and left in place. There should be no land use impact.

TRANSPORTATION AND UTILITY NETWORKS

Construction Phase

The pipeline route crosses the Skagway river and its tributaries, but since none of the waterways are considered navigable, no intersections with inland water transportation would occur.

From the onshore storage facility to Canada, the pipeline route does not cross any roads or highways. However, increased traffic is expected on the Skagway-Carcross Highway due to the shutdown of the White Pass and Yukon Railway during construction of the pipeline. Passengers and freight originally hauled by the railroad will be diverted to the highway. This increased volume is not expected to significantly affect traffic flow. Increased usage and truck traffic could increase maintenance and repair of the highway.

During construction, operation of the present White Pass & Yukon Route would be interrupted for substantial periods during one peak summer season. The expected procedure would be for construction crews to remove tracks for blasting and replace them afterwards. In this manner, a constant rail transportation link would be maintained to haul rock away from the immediate construction site and to transport pipe and material along the proposed route.

The impact of this procedure on tourism would be severe. The popular Lake Bennett tour would be interrupted. This could discourage tourism, consequently, diminishing ferry, air, and highway passengers for as long as the Lake Bennett tour is not offered. Another loss would be approximately 48,500 railroad passenger trips between Skagway and Whitehorse.

The White Pass & Yukon Route would lose revenues in passenger service. Revenues from the project's use of the White Pass & Yukon Route's wharf, onshore storage facility site and the railroad's right-of-way could offset the loss of revenues from diminished passenger and freight traffic.

In addition to the impact of decreased passenger volumes, losses of freight and ore shipments would also be experienced. Freight shipments would be shifted to truck movements along the Skagway-Carcross highway. Pending economic investigation, the ore would either be trucked or stockpiled until the railroad is restored.

Also hauled on the existing Skagway-Whitehorse run are gas and aviation fuel destined for the Yukon. For the duration of the interrupted rail operation, this fuel would need to be delivered by tanker truck.

There would be no interaction between the project and airplanes or their passengers.

The construction phases of the pipeline system should not cause any significant impacts to electric transmission or communication lines and facilities.

The proposed pipeline would generally follow the alignment of the existing CANOL Line. During construction, operation of this line would be interrupted, adversely affecting its operation. Since temporary interruption of the CANOL line would occur in the peak summer season of the second construction year, tanker trucks would be needed to transport stored fuel to the Whitehorse and Yukon area.

Operation Phase

During operation, the pipeline system would normally have no significant adverse effect on the railroad.

If an oil spill, fire, or explosion occurred it might be necessary to close down the rail line during repair and clean-up operations, adversely affecting passenger and freight traffic.

Also during the operation phase, the pipeline system would normally have no adverse affect on the CANOL pipeline. However, if an oil spill occurred it might be necessary to shut down the line during repair and clean up operations, interrupting heating oil service to Whitehorse and the Yukon.

Abandonment Phase

It is not expected that abandonment would disrupt the CANOL line.

RECREATION

Construction Phase

Clearing operations for the proposed pipeline would occur between July and September of the first year and between May and September of the second season. Construction, noise from blasting, and other activities would impair use of the White Pass and Yukon Route railroad for the duration of construction and pipelaying activities. Passenger use would be reduced and possibly eliminated as a result of the applicant's proposal to use the railroad for construction. This would be considered a severe impact to tourism.

East of the proposed pipeline crossing of the Skagway river, pipeline construction is likely to pass through or very near a proposed Alaska state campground. If the campground is in operation by 1980 or 1981, the noise, disruption, appearance, and possible loss of campground space would curtail and impair camping activity. Campground development and pipeline construction could, however, occur during the same year or the pipeline could precede the campground.

A number of scenic and recreational attractions along the pipeline route would be temporarily affected by construction activities.

Impacts of construction activity upon trails in the corridor (White Pass Trails and Brackett Wagon Road) would curtail or cause suspension of use. This would depend largely upon the extent to which trails have been restored and interpretive facilities developed by the time pipeline construction occurs. Trails within the National Historical Park are of particular concern since future restoration is currently being planned.

Construction activities could also interfere with proposed development or use of national historical park campsites and interpretive centers at White Pass City and White Pass summit. How extensive development or use would be at the time of pipeline construction cannot be determined.

Construction activities would not affect sport fishing in lakes and streams in the area.

Operation Phase

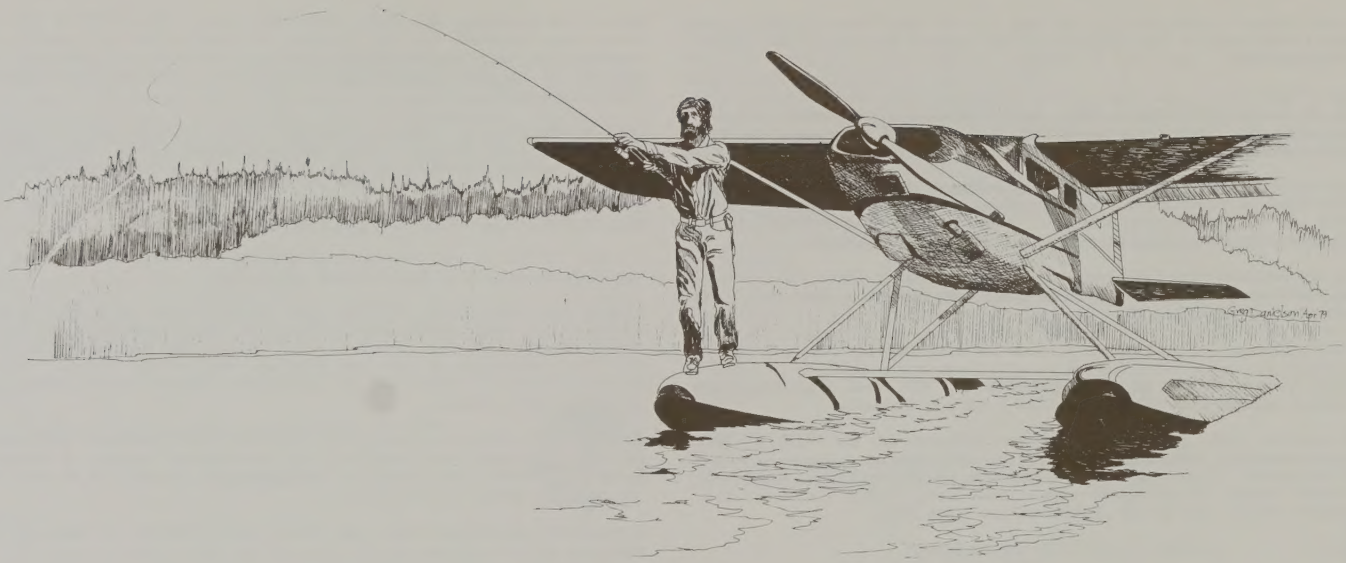
If an oil pipeline rupture should occur, significant recreational activities and areas could be seriously impacted. Impacts would depend upon the location and severity of a rupture. Since hunting and potential sport fishing areas are located at higher elevations, a spill would principally curtail or impair use of trails, degrade appearance of scenic and cultural attractions located along the route and impede access to hunting or fishing areas.

With the proposed pipeline in place the aesthetic characteristics of the Skagway valley would have been altered. This impact on recreational users would largely depend upon the degree to which they are seeking a wilderness or historic experience and find the recent cuts a detraction from recreational enjoyment. Similarly, the views from the train and highway would be affected.

Normal operation should not affect hiking, camping, hunting, or fishing.

Abandonment Phase

Abandonment of the pipeline would result in short term inconvenience and some nuisance for users of recreational resources.



Lake Fisherman

ECONOMIC CONDITIONS

Impacts of the pipeline route are the same as those discussed in 8.2.3, Economic Conditions section for the port.

SOCIAL CONDITIONS

Social impacts related to the pipeline system are the same as those related to the port and onshore storage facilities, as discussed in 8.2.3, Social Conditions section.

8.2.4 MITIGATING MEASURES NOT INCLUDED IN THE PROPOSAL

Measures which could reduce the impacts identified in section 8.2.3 are assessed as possible mitigating measures.

Most proposed impact reducing measures are project design features, construction-reclamation methods, or operating procedures, which are discussed in chapter 1. Federal and state agencies and private landowners could require additional measures as special conditions to permits and easements.

The proposal defines the pipeline route as 2-mile wide corridor. The port and onshore storage facilities and the pipeline system are discussed in terms of preliminary design criteria. Federal, state, and local agencies require more specific information on proposed locations, design of system components, construction schedules and methods, reclamation methods, and operating procedures to determine what mitigating measures would be required. Private landowners also need more site specific details in order to determine measures they would require as easement provisions. For these reasons, the possible mitigating measures contained in this chapter should not be considered all inclusive.

The possible mitigating measures in table 8.2.4-1 address only the significant impacts identified in section 8.2.3. They are considered reasonable enforceable measures which might be included as terms and conditions to permits, easements, or right-of-way grants issued by private individuals, local, state, or federal agencies should the NEC proposal be approved.

TABLE 8.2.4-1 POSSIBLE MITIGATING MEASURES APPLICABLE TO ENTIRE PROJECT

Mitigating Measure	Effectiveness	Environmental Component
Loading pipeline and unloading pipeline away from landslides and alluvial valleys, or use stronger pipe in such areas.	Reduce potential oil spills from seismic activities. Stronger pipe would withstand larger seismic stress and landslides. Locating pipelines across bedrock would be nearly 100% effective in preventing a pipeline rupture from ground shaking and liquefaction.	Topography and Geology
Avoid threatened or endangered plants and animals	Threatened or endangered species could be protected. This measure would be 90 to 100 percent effective	Terrestrial Vegetation, Wildlife, Aquatic and Marine Resources
Restrict or reduce construction times to minimize impacts on wildlife reproductive periods.	Critical periods for moose and mountain goat are May and June; for bear are April and May; waterfowl are April through June; seals are April and May; and sea lions are June and July. This measure would be 70 to 100 percent effective.	Terrestrial Wildlife and Marine Resources
Provide temporary housing (including sewage and water) in Skagway for 400-500 personnel employed during construction phase who would not be housed in the construction camp.	Reduce demand on permanent housing in Skagway; reduce amount of permanent housing left vacant after construction; reduce impact on local hotels. This measure would be 80 to 90 percent effective.	Social, Economic, and Recreation
Avoid impacts to historical and archeological sites; preserve artifacts.	This measure should be 90 to 100 percent effective.	Cultural
Periodic sampling of existing and new test wells.	100 percent effective in providing early warning of oil contaminated water near major aquifers.	Aquatic Resources
Employ vessel control and traffic system. Thoroughly train tanker pilots. Improve navaids.	Systems scheduling barge deliveries during construction such as one-way traffic minimum separation distances restriction of movements during storms or designated fishing periods, and limiting speeds would reduce accidents, as would the use of well-trained pilots and improved navaids. Effectiveness would be 90 to 100 percent.	Marine and Resources Recreation
Restrict construction around the harbor and onshore storage facility site during the summer months and limit work during night time hours.	Reduce annoyance, congestion, and noise during the peak tourist season. This measure be 50 to 75 percent effective.	Recreation and Transportation

TABLE 8.2.4-1 (Continued)

Mitigating Measure	Effectiveness	Environmental Component
Establish ground-to air-communications during construction of unloading pipeline along airport runway.	Eliminate possibility of construction equipment and workers obstructing landings. This measure should be 100 percent effective.	Transportation
Locate pipeline away from historic and tourist sites.	Preserve integrity of railroad bed, stations, and viewpoints; protect pioneer cemetery, White Pass City, Brackett Road, White Pass Trail, Liarsville camp and Heney camp. This measure should be 95 to 100 percent effective.	Cultural Resources and Recreation
Remove waste rock from park unit for removal.	Reduce damage to vegetation and visual resources associated with the park by an estimated 20 to 35 percent.	Visual and Cultural Resources, Vegetation and Recreation
Avoid use of herbicides for corridor maintenance.	Prevent impacts of herbicides on vegetation adjacent to corridor; prevent introduction of herbicides into food chain. This measure would be 100 percent effective.	Wildlife, vegetation, visual, and recreational

8.2.5 ANY ADVERSE IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

This section assumes the proposal as described in chapter 1 is implemented and that the impacts on the environment (see section 8.2.3 Environmental Impacts) are mitigated by the measures described in the previous section (8.2.4). The impacts identified in this section remain after mitigating measures have been applied, and are termed unavoidable adverse impacts. This section identifies, summarizes, and where possible quantifies those unavoidable adverse impacts.

SEA LEG

If the mitigating measure of installing and operating a modern Navaid system were implemented, the incremental risk of an oil spill from tankers in transit to Skagway would be reduced to near the existing risk level of one spill $\geq$ 2.4 barrels every 7.2 years (see table 8.2.3-1).

PORT AND ONSHORE STORAGE FACILITIES

CLIMATE

No adverse impacts to climate are expected from the proposal.

AIR QUALITY

Impacts on air quality in Skagway are not expected to exceed the Class II rating, which is not considered significant. Impacts as a result of oil spills, fires, and explosions would be intermittent and of short duration.

NOISE

The impact of noise is unavoidable during construction. However, construction would be mitigated and therefore considered not significant. Noise associated with oil spills, fires, explosions, and their clean-up would be short-term and considered not significant.

TOPOGRAPHY AND GEOLOGY

No mitigating measures have been identified in section 8.2.4; unavoidable adverse impacts would be the same as those described in section 8.2.3, Topography and Geology. Table 8.2.5-1 summarizes these and, where possible, their magnitude and duration.

TABLE 8.2.5-1 SUMMARY OF RESIDUAL ADVERSE IMPACTS, PORT AND ONSHORE STORAGE FACILITIES

Environmental Component	Project Phase	Residual Adverse Impacts
Topography	CONSTRUCTION	Alteration of 73 acres of land at the storage facilities by levelling and grading and 2-3 acres on coastal headland by construction of the port facility.
Physical geology		Alteration of rock characteristics at the port facilities and removal of 70,000 cubic yards of bedrock resulting in increased erodibility and potential for slope failure.
Geologic hazards Seismicity		A large magnitude earthquake could produce landslides and cause loss of life and equipment if it exceeded design criteria.
Slope instability		Excavation could result in landslides along the coastal bluff and could result in loss of life and equipment.
Mineral resources		Sand and gravel along Skagway River could become unavailable for other uses.
Topography	OPERATION	Modification of topography near the port would exist for the life of the project.
Physical geology		No identified impacts.
Geologic hazards Seismicity		Increased potential for rockslide or rockfall above port facility due to cut for offloading pipeline and service road.
Ground shaking		Strong ground shaking generated by an earthquake that exceeds design criteria could damage structures to the point of rupture causing fires and/or oil spills.
Liquefaction		Liquefaction of either the harbor soils or loose sands in the area of the unloading pipeline could result in a rupture to the system, causing an oil spill and long-term harbor contamination.
Slope instability		Submarine or onshore slope failures could case rockfall or remove support under port or onshore storage facilities, or rupture the unloading pipeline, possibly causing an oil spill.
Mineral resources		No identified impacts.
Topography	ABANDONMENT	A permanent scar on the coastal bluff where the road and port facility would be constructed.
Physical geology		No identified impacts.
Geologic hazards Seimicity Ground shaking Liquefaction		The residual adverse impacts are the same as those described under the operation phase but less severe because the pipeline would contain an inert material.
Slope instability		Rupture of pipeline could release an inert material rather than oil.
Mineral resources		No identified impacts.

SOILS

Impacts on soils from large spills, fires, or explosions involving the unloading pipeline would probably affect no more than 1,000 acres; however, many thousand of acres could be involved in a marine accident, which would be significant.

AQUATIC RESOURCES

Physical Components

No significant impact on the regional water table is anticipated. Simultaneous rupture of two or more storage tanks would release over a million barrels of oil into the river and harbor. A rupture in the unloading pipeline would spill up to 12,000 barrels of oil into the river and harbor.

Biological Components

Sediment resulting from instream excavation of the pipeline adjacent to the onshore storage facility and from streambank and storage site erosion could infiltrate trout and salmon spawning areas and reduce their populations by an unknown amount if spawning areas are found downstream from the site. Reduced populations would probably recover within several spawning cycles.

An oil spill, fire, or explosion could significantly reduce the number of fish and insects downstream from the spill site. Oil contaminated spawning gravel could reduce the production of fish for several months following a spill. Recovery of reduced populations would take several spawning cycles in most cases.

MARINE RESOURCES

Physical Components

Construction at the port would expose pollutants in sediments and would suspend fine-grained sediments. The suspended and dissolved materials could temporarily increase biochemical oxygen demands, thereby depressing the dissolved oxygen levels in seawater. They could also increase toxicity levels and turbidity in the water column. Release of soluble nutrients would further lower the dissolved oxygen levels. The amount or kinds of pollutants cannot be quantified, it is not known whether there would be a significant impact.

Chronic oil spills would increase levels of dissolved hydrocarbons in the seawater. Spilled oil that was not rapidly and completely recovered by booming and skimming would release soluble hydrocarbons and possibly heavy trace metals associated with crude oil into the marine environment. The water quality of the surface, near surface, and to a lesser degree deeper water, would be degraded.

A massive oil spill might be contained within Skagway harbor or in the vicinity by strategic booming of the oil slick. However, an oil slick shoreward of the booms would be expected to reach the beaches. Moreover, soluble petroleum fractions would severely degrade water quality in the harbor and surrounding waterway.

A tanker casuality with complete loss of cargo would create an adverse, unavoidable impact on water quality. Booms might be partially effective in retaining the oil slick but effectiveness would depend on the meteorological and oceanographic conditions at the time of the incident. Skimmers would be ineffective in moderate to heavy seas.

If mechanical means were used in beach cleanup operations after a pipeline rupture or tanker casualty beach removal would upset the shoreline equilibrium. Excessive removal of beach could lead to erosion unless enough sand and gravel were available to replace removed materials.

Biological Components

Suspended and dissolved heavy trace metals, lowered dissolved-oxygen levels, chlorinated hydrocarbons, petroleum hydrocarbons, and sulfides might stress marine organisms, altering their patterns of mating, feeding, and aggression. The combined effect could increase mortality.

Turbid water conditions would diminish the penetration of sunlight, decreasing phytoplankton photosynthesis. This is considered an unavoidable adverse impact. However, any reduction would be local and would not involve the entire population of marine phytoplankton in the greater Chatham Strait waters.

Chronic oil spills from tanker off loading could cause subtle changes in organisms and communities and possibly distribution of trace metals found in crude oil through the food chain. The effects from crude oil and petroleum derivatives result from lethal and sublethal toxic concentration of the seawater soluble fractions. Exposure of phytoplankton and zooplankton, especially eggs and larvae, would have significant local, unavoidable adverse impacts.

Birds coming in contact with crude oil would probably die, particularly in a winter spill. Sea ducks and other diving birds would be the most susceptible.

Marine mammals generally avoid oil polluted water.

A large oil spill at the port would cause local mortality to phytoplankton and zooplankton, fish eggs, and larval forms of fish and bottom organisms. Intertidal organisms in the harbor would be coated and smothered by a noncontained oil slick. Sea bird populations could be reduced, particularly in the harbor.

An in-transit tanker casualty resulting in an oil spill in Lynn Canal and Chatham Strait would result in high mortality of plankton, diving birds, and intertidal and subtidal organisms would occur. Seals and whales would probably avoid the contaminated areas.

Oil-spill cleanup vehicles or vessels operating near seal rookeries could disturb the animals. Adults disturbed during breeding might abandon their pups.

Increased ship traffic in Chatham Strait and Lynn Canal could cause some ship-whale collisions; however, the probability of such incidents is very low.

TERRESTRIAL VEGETATION

Preparation of the unloading pipeline and the onshore storage facility site for construction would result in the removal of all vegetation on about 135 acres. However, this is not considered significant because most of the area has already been disturbed.

TERRESTRIAL WILDLIFE

The most important wildlife concern is impacts on bald eagles. Lost roosting habitat would cause eagles to relocate if other habitat were available. Disturbances from construction and increased activity nearby could cause eagles to abandon traditional feeding areas along the adjacent shoreline. Quantification of this impact is not possible. A large oil spill would contaminate food and feeding areas; it could cause mortality.

CULTURAL RESOURCES

Most unrecorded cultural, archaeological, historical, and palentological sites would probably be identified, and adverse impacts on most of the identified sites would be avoided. However, even with mitigation some sites may be lost. Oil spills, fires, and explosions could destroy some sites.

VISUAL RESOURCES

The proposed port would be viewed from the harbor and from Skagway as a massive man-made intrusion. The new port would be visually offensive to some people, while others would consider it interesting. Excavation of road to the port would permanently scar the cliff face, an unavoidable visual intrusion.

Tankers rise in the water as they discharge crude oil. The bulk of an unloaded tanker would be considered an adverse visual impact by many viewers. Others would consider this an interesting and typical view of port activity.

LAND USE

Much of the land that is involved in the proposed port and onshore storage facilities has already been dedicated to commercial land use, so the impact is not considered significant. Without careful scheduling, barges could clog the harbor facilities.

Oil spill, explosion, or fire might adversely impact land uses adjoining the port and onshore storage facilities. The probability of these events and their possible impacts are shown in table 8.2.5-2.

TABLE 8.2.5-2 POSSIBLE UNAVOIDABLE ADVERSE OIL SPILL, FIRE, EXPLOSION IMPACTS

Event	Probability 1/ once every:	Possible Impacts
Large oil spill in Chatham Strait 10,000 barrels	51 years	Would impact coastlines.
Large oil spill in Skagway Harbor 10,000 barrels	480 years	Would impact ferry berth and industrial, commercial, and recreational land uses bordering the harbor.
Fire at port facility	38 years	Smoke impacts to land uses indicated above; possible temporary interruption of water and road access to harbor area.
Fire at onshore storage facility	unknown	Smoke impacts on nearby business and residential areas.
Tanker explosion in harbor	92 years	Would cause damage and loss of life at ferry berth, to nearby vessels in harbor, and to recreationists.
Explosion at onshore storage facility	unknown	Might cause physical damage or loss of life at nearby residences.

Source: NEC 1979

1/ Expressed in probable number of years per occurrence for incremental spill frequency.

TRANSPORTATION AND UTILITY NETWORKS

No significant impacts to transportation and utility networks are expected as a result of the construction, operation, or abandonment. Significant impacts would occur as a result of oil spills, fires, or explosions, particularly if the harbor were involved. Such accidents, if severe, could eliminate much of the transportation to or from Skagway for short periods of time. These impacts cannot be quantified.

RECREATION

Table 8.2.5-3 summarizes some of the more significant, unavoidable impacts in Skagway and at the onshore storage facility as a result of the proposed action.

TABLE 8.2.5-3 SUMMARY OF UNAVOIDABLE ADVERSE IMPACTS TO RECREATIONAL ACTIVITIES

Impact	Comment
Short-term inconvenience to recreationists using the harbor area	Project related activities in the harbor would create nusiance impacts (noise, congestion, etc.) to casual day users of the harbor.
Long-term harbor traffic congestion and hazards to marine angling and pleasure boating	Tankers in turning, queuing, and at berth would create hazardous conditions for small recreational craft.
Short-term loss of offshore salmon fishing	Anglers would be inconvenienced by project construction vessels in the area.
Short-term decreased availability of municipal parks and recreational facilities	Construction crews and their families would increase pressure on existing recreational parks and facilities.
Potential short-term loss of marine related recreation due to oil spill, fire, or explosion	A tanker casualty involving an oil spill at any point along Chatham Strait, Lynn Canal or in the harbor would create the potential for impacting marine related recreation including tourism.

ECONOMIC CONDITIONS

Table 8.2.5-4 lists the unavoidable adverse impacts to the economics of the port area.

SOCIAL CONDITIONS

Table 8.2.5-4 lists the unavoidable adverse impacts to the social resources of the port area.

TABLE 8.2.5-4 UNAVOIDABLE ADVERSE IMPACTS—ECONOMIC AND SOCIAL

Impacts	Unavoidable Adverse Impacts
Population	
Construction	
Peak influx	Housing shortage
Increase in population of about 460 people during operations	Housing shortage
Abandonment would mean the loss of 114 jobs: temporay influx of less than 100 workers to disband system	Significant economic impact. Loss of $1-2 million in personal income and city and state taxes.
Closing railroad during construction	Loss of jobs and elimination of hauling and tourist use of railroad.
Loss in economic value of fisheries in event of major spill	Same as impacts.
Possible damage to life and property in vicinity of harbor fire or explosion	Same as impacts.
Abandonment	
Decrease of $1-2 million in personal income	Same as impacts.
Workers would have difficulty finding temporary housing accommodations during construction; rents would increase.	Dependent upon degree of involvement by applicant; amount of aid for loans and/or housing plans.
Rental housing market would be initially tight during operation.	Grants or loans received by the community could apply to operation phase if needed. If NEC initiated action before operation, housing impacts could be mitigated.
Possible strain on law enforcement personnel from increase in misdemeanors and traffic problems during construction phase.	Dependent on timely application for and receipt of assistance.
A major fire in the harbor or at the onshore storage facilities would significantly strain local departments, possible loss of life	Same as impacts.
During construction nuisance impacts due to crowded conditions, strain on employees; residents, tourists.	Same as impacts.

PIPELINE ROUTE

CLIMATE

No impacts to climate are expected.

AIR QUALITY

Construction Phase

Construction of the pump station and pipeline would result in emissions of combustion products such as nitrogen oxides, carbon monoxide, hydrocarbon, and particulates and localized concentrations of these pollutants. These concentrations would be within air quality standards, would be temporary, and would be confined to the immediate vicinity of the construction site.

Fugitive dust emissions would be unmitigated along most of the proposed pipeline corridor. However, the duration at any particular point would generally be less than a month.

Operation Phase

Impact of hydrocarbon emissions at the pump station would be negligible. However, the hydrocarbon emissions would not increase ozone concentrations in the atmosphere. The amount of emissions from the motors which would power the electric generators and pump station AL-1 are unknown.

Abandonment Phase

Residual impacts of abandonment operations would be similar to those associated with construction. Impacts on air quality would be confined to the vicinity of the abandonment site and pollution concentrations would be within air quality standards. Fugitive dust emissions would be temporary and would have no impacts outside the vicinity of the abandonment operations. Fugitive dust problems would be expected to continued after abandonment.

NOISE

Construction Phase

A limited number of residences would experience relatively high noise levels from construction activities at the proposed pump station. Construction of the proposed pipeline would affect residences in proximity to the proposed pipeline. High noise levels would occur primarily in the daytime and would generally last for less than a month.

TABLE 8.2.5-5 SUMMARY OF RESIDUAL ADVERSE IMPACTS-PIPELINE ROUTE

Environmental Component	Project Phase	Residual Adverse Impacts
Topography	CONSTRUCTION	Landform changes throughout the entire route as a result of construction activities. About 11-13 acres per mile would be changed in gentle terrain and 14-25 acres per miles in mountains (the majority of the route).
Physical geology		Alteration of the physical characteristics of the rocks, increasing the potential for slope failure, particularly in steep terrain. Moderate to large volumes of rock would be removed during excavation (0 to 1.2 million yd^3/mile).
Geologic hazards Slope instability		Excavation in steep areas could create landslides or other mass movements in unstable areas and could cause loss of life, structures, utilities, and construction equipment.
Mineral resources		Sand and gravel resources not available for other uses.
Topography	OPERATION	Modified terrain increases snow drift accumulation along route.
Physical geology		No impacts identified.
Geologic hazards Seismicity		NA
Ground shaking		Strong ground shaking generated by a large magnitude earthquake that exceeded design criteria could impact a part of the system causing a rupture and an oil spill.
Surface fault rupture		At crossings of active faults, fault movement could distort the pipeline line beyond design criteria, rupturing the line and causing an oil spill of several thousand barrels.
Slope instability		Slope failure (landslides, snowlides, etc.) that exceeded design criteria could rupture the pipeline, causing an oil spill, particularly in steep areas.
Outburst flooding		High scour and streambank erosion generated from a massive outburst flood could expose the pipeline and threaten integrity of the line.
Mineral resources		Impacts are the same as those identified for the construction phase.
Topography	ABANDONMENT	Permanent scars would remain where excessive excavation in steep terrain was required to permit pipeline construction.
Physical geology		No impacts identified.
Geologic hazards Seismicity Ground shaking Surface fault rupture Liquefaction Slope instability Outburst flooding		No impacts identified.
Mineral resources		No impacts identified.

Operation Phase

Unavoidable noise would be generated by operation of the pump station. However, noise levels would not be excessive, and few residences would be affected.

Fewer people would be involved in the noise impacts during construction of the pipeline because most of the construction would be away from Skagway and homes. Noise impacts, while avoidable, would not be considered significant.

Abandonment Phase

Unavoidable impacts would generally be the same as during the construction phase. Some residences would be affected by relatively high noise level, generally for less than a month.

TOPOGRAPHY AND GEOLOGY

No significant topographic or geologic mitigating measures have been identified in section 8.2.4; unavoidable adverse impacts would be the same as impacts described in section 8.2.3 (Topography and Geology).

The magnitude and duration of the impacts would be the same but could only be quantified for impacts to the topography and physical geology. The geological sciences, while often able to determine where the potential exists for a catastrophic geologic event such as earthquake or slope failure, have not developed to the point that the time, duration and magnitude of such an event can be predicted with any degree of reliability.

The probability and magnitude of a geologic event occurring during a specific period is based on a relatively large data base, particularly the history, the physical and chemical properties of the geologic material, and the configuration of the terrain. The data gaps in the geologic data base for the pipeline system are numerous. The probability and probable magnitude of any geologic event occurring during the estimated 20-year life of the project cannot be determined with any degree of reliability.

Table 8.2.5-5 summarizes the residual adverse impacts (and, where possible, their magnitudes and duration) identified for the pipeline system.

SOILS

Construction Phase

Quantification of residual impacts along the pipeline is complicated by the diversity of soils, topography, protective ground cover, and climate. Insufficient data permits quantification only in a very general sense. Only relative rates of soil losses are given. Although total soil losses cannot be calculated it is possible to gain some insight as to what can be expected to occur at specific locations under varying conditions. It is possible that some mitigating measures would not be as effective as predicted. Revegetation could be delayed or hampered by natural causes such as drought, heavy rainstorms, hailstorms, or by disease and insect infestations. Settling ponds could be damaged by flash floods. Organic mulches could also be removed by fire or floods.

Unavoidable soil losses would occur along the entire length and width of the pipeline right-of-way, at the pump station, temporary pipe stockpile yards, block valve locations, and in an undetermined area occupied by access roads. Loss of vegetation and topsoil disturbance and alteration would cause an estimated 5 percent loss in soil productivity. Soils in the right-of-way would produce nothing during construction. Soil erosion would be a major impact.

Impacts to soils along the pipeline would probably affect up to 2,000 acres. Impacts would be considered significant.

AQUATIC RESOURCES

Physical Components

Construction Phase

Surface water quality would be degraded by increased turbidity and siltation during clearing, trenching, pipe installation, and backfilling operations. The company would limit construction to low flow periods when possible, which would mitigate impacts by reducing the sediment-carrying capacity of a narrower stream. Some increase in siltation and turbidity would result during and after construction. Intensity and duration of the impact would depend on characteristics of individual stream crossings. If scheduling or weather conditions precluded stream crossing construction during low-flow periods, sediment and siltation would be more severe.

Stream baseflow would be decreased for the hydrostatic test water withdrawal period. Intensity of impact would depend upon stream discharge at time of withdrawal. The low flow in some streams at certain times would not be adequate for withdrawal of hydrostatic test water.

The pipeline would be buried 48 inches below 100-year flood scour depth. A flood of greater magnitude could expose the pipeline. Pipeline exposure would subject the pipe to streamflow forces, greatly increasing the potential of rupture.

Operation Phase

Oil-spill potential would exist, although the probability of a pipe rupture is low. The severity of the impact would depend on the amount of oil spilled, chemical constituents of the oil, time of oil containment, topography of the area, volume of river flow, and time of year.

Oil spill impacts would depend on location and volume of oil spilled, depth to water table, water table gradient, and permeability of subsurface materials. Shallow aquifers would be most vulnerable. Since most Skagway residents have their own wells, a major upstream oil spill could result in contaminated groundwater which could last for many years.

Abandonment Phase

Removal of pipe from areas adjacent to streams would increase sediment concentration and siltation impacts to surface water. Sediment would be carried to the stream by surface water runoff until vegetation or erosion control measures were established. In general sediment degradation of water could be anticipated for about one growing season.

Prior to pipe removal, if any, water would be passed through the pipe to flush the system of oil wastes and combustible gases. Consequently, use of holding ponds and treatment of water would be required before water could be discharged to receiving areas. If holding ponds leaked, contaminated water could migrate to ground water. Proper engineering design would alleviate infiltration and percolation potential, so no adverse impact to water resources would be anticipated.

Biological Components

Sedimentation of spawning areas would reduce salmon and trout populations. Several spawning cycles would be required for reduced populations to recover to preproject levels. Inital population reductions would probably not be noticed in ocean sport, commercial, or Native American fisheries.

Fish populations would be reduced in the event of an oil spill. Several spawning cycles would be required for the reduced populations to fully recover to prespill levels. Severely reduced salmon populations might require 20 years for complete recovery. The reduction of salmon and searun trout populations would probably not be noticed in the ocean sport or commercial fisheries, but might be noticed in the river sport fisheries, especially if large numbers of one or more year-classes of fish were eliminated by a large spill.

MARINE RESOURCES

Physical Components

Construction Phase

No significant unavoidable adverse water-quality impacts to the marine environment in Lynn Canal are anticipated as a result of construction of the pipeline.

Operation Phase

In the event of a river-crossing pipeline rupture, crude oil components could be transported into the upper, less dense and less saline water layers of Lynn Canal. This upper layer would be degraded by the dissolved oil fractions and by the spreading surface oil slick. Since there is a seaward surface flow, the degradation of water quality in Lynn Canal could be far-reaching, and the oil slick too thin to be effectively picked up by skimmers.

Abandonment Phase

No unavoidable adverse water quality impacts to the marine environment would result in abandonment of the pipeline.

Biological Components

Construction Phase

Construction of the overland and river-crossing pipeline near Lynn Canal would present no significant impacts to the marine environment.

Operation Phase

Unavoidable adverse impacts to Lynn Canal would occur should there be a pipeline rupture at a river-crossing. Oil is likely to be incorporated into the fine-grained salt marsh sediments, prolonging biological recovery for years. Shorebirds who frequently use the saltmarsh would be severely impacted and high mortality of these animals could be caused by loss of body heat and ingestion of oil-contaminated food. Low hatchability of shorebird eggs would also be expected if the spill occurred during the breeding season.

Seal hauling-out areas could be severely oiled. Although little is known about the effects of oil on seals, some observations indicate that weights of oiled pups were significantly lower than those of unoiled pups and that there was no difference in mortality between oiled and unoiled pups. Oil-cleanup activities near rookeries might cause the cows to abandon their pups.

Depending upon the location and size of the oil spill, shellfish could be killed or tainted. Tainting would result from ingestion of oil droplets, oil-contaminated plankton and sediment, and from the water-soluble crude oil fractions. The shellfish might also ingest oil-associated heavy trace metals.

Open water inhabitants, especially ducks and diving birds, could be attracted by the oil slick and suffer high mortality. As with the shorebirds, sea duck and diving bird egg hatchability would greatly be reduced. Seals and whales, as well as fish, might avoid oil-polluted waters. However, fish might become tainted and might contain excess body burdens of carcinogens and heavy trace metals as a consequence of feeding habits. Bald eagles scavenging tainted fish could suffer high mortalities.

Phytoplankton and zooplankton would suffer high mortality, but this would be a local unavoidable adverse impact of short duration. Planktonic forms would return after the oil was naturally dispersed or cleaned up by mechanical means.

Abandonment Phase

No unavoidable adverse impacts to marine biota in Lynn Canal or Chatham Strait would occur during abandonment of the overland and river-crossing pipeline.

TERRESTRIAL VEGETATION

Construction Phase

Preparation of the pipeline right-of-way for construction would result in the removal of all vegetation on 135 acres.

Operation Phase

Impacts resulting from wind damage to an unquantifiable amount of vegetation peripheral to the pipeline corridor could not be mitigated.

Abandonment Phase

The character of the vegetation along the pipeline corridor would be unavoidably altered for the duration of the project and for many years thereafter.

WILDLIFE

Construction Phase

Waterfowl nest loss would depend upon the timing of construction. Construction during spring or early summer would result in reduced waterfowl populations for the year.

Impacts from permanent alteration and loss of coniferous cover would include decreased thermal protection for moose and mountain goat. Increased browse would later become available, increasing the suitability of specific areas for big game animals.

Alteration of habitat at major stream crossings could also change watering and feeding activities related to riparian habitats and streamside clearings.

Operation Phase

Impacts on wildlife from oil spills would depend upon season, location, species vulnerability to petroleum contamination, and effectiveness of cleanup efforts. Most seriously impacted would be waterfowl with low reproductive rates whose young require prolonged postnatal care. Waterfowl recovery from a severe impact with high mortalities could take more than 50 years, which is the time required for doubling populations. Residual oil spill impacts to raptors and game birds are expected to be minimal. The behavior of larger mammals including grizzly bear, gray wolf, and kit fox is not expected to be significantly altered by an oil spill.

Habitat alterations at major stream crossings could persist for the life of the project, potentially changing waterfowl behavior. Impacts of stream crossings and construction activities near and within riparian habitat could result in the loss of the only available habitat for some species.

Abandonment Phase

Residual impacts are expected to be similar to impacts described for construction.

CULTURAL RESOURCES

If the mitigating measures outlined in 8.2.4, Cultural Resources, are fully implemented, most presently unrecorded cultural resource sites would probably be identified. Those sites, plus the ones previously known, would in most cases be preserved and protected. However, even with full implementation of the mitigating measures, unavoidable adverse impacts could occur.

Archaeological and Historical Resources

Some sites along the pipeline right-of-way might not be identified during the preconstruction surveys. Damage would occur at such sites before materials were noted and construction halted.

Any archaeological site which could not be avoided and thereby preserved in place would suffer unavoidable adverse impacts, even if all appropriate care were taken during the data recovery operation. Though a portion of the materials and much information would be preserved, the sites themselves would be destroyed and any potential for future study and/or interpretive development would be lost.

Inadvertant damage to sites would result simply from use of the land. Some intentional damage to sites by collectors would occur during both the construction and the operation phases of the project.

Paleontological Resources

Since most of the area to be traversed by the pipeline is metamorphosed rock, the possibility of fossil material existing is remote.

VISUAL RESOURCES

Construction Phase

Installation of the pipeline in a 90-foot right-of-way would intrude significantly on the scenic quality as viewed from the Skagway-Corcross Highway, several hiking trails, and recreation areas. This is an unavoidable adverse impact.

Construction of the pipeline in this section would result in unavoidable visual impacts that would persist beyond the life of the project.

Operation Phase

An oil spill of any magnitude could be classified as an unavoidable adverse visual impact if located in a critical view-shed, and/or on a steep slope.

Abandonment Phase

If the pipeline were removed from its trench (except for major river crossings), the short-term visual impacts of the abandonment phase would be similar to those caused during the construction phase.

LAND USE

Construction Phase

Unavoidable impacts include temporary disruption; conversion to project use; and nuisance impacts of dust, noise, visual disharmony, and traffic delays. Impacts would be most severe near the urban fringe areas.

Construction would would affect approximately 250 acres. However, none of the acreages appears to suffer a significant impact in terms of land use.

Through urban areas construction impacts should be limited to nuisance impacts discussed in other sections. No relocations of persons should be required.

About 80 acres of forest and woodland would be cleared during construction.

Operation Phase

Significant impacts to land use might occur as a result of an oil spill and subsequent reclamation activity. Large spills, particularly if they occurred on steep slopes or at stream or river, crossings might affect land uses away from the right-of-way.

Abandonment Phase

If the pipeline were removed, it would cause impacts similar to those incurred during construction. Urban land uses might be significantly impacted. Although the removal process would likely be of shorter duration, the nuisance impacts of noise, dust, visual disharmony, and traffic disruption might be felt more intensely because of the intensive urban development that is apt to encroach upon the pipeline during the intervening 20 years.

TRANSPORTATION AND UTILITY NETWORKS

Construction Phase

Project-related vehicles and construction activity would cause traffic congestion on some streets near Skagway for periods up to 18 months.

Railroad traffic use would be eliminated for at least one tourist season.

Construction activity might damage nearby transportation and utility systems.

Use of the existing CANOL pipeline would be interrupted, since NEC intends to place both the oil pipeline and the CANOL pipeline in the same trench.

Operation Phase

An oil spill and resulting cleanup activity might cause damage to nearby transportation and utility systems, including the adjacent CANOL pipeline.

Abandonment Phase

Transportation and utility facilities near the pipeline might be damaged if the pipeline is removed. No other significant adverse impact would be likely to occur.

RECREATION

Table 8.2.5-6 summarizes the unavoidable impacts anticipated along the pipeline route as a result of the proposed action.

TABLE 8.2.5-6 SUMMARY OF UNAVOIDABLE IMPACTS ON RECREATIONAL ACTIVITIES

Impact	Comment
Long-term losses and inconvenience to sightseers and photographers Degradation of park lands. Accumulation of rock piles from blasting.	Losses in visual attractiveness would be sustained along the existing railroad and the Skagway-Carcross Highway.
Short-term inconveniences to recreationists using areas along right-of-way or the railroad. Crowding of facilities.	Construction and abandonment would disrupt existing recreational use of areas in and near the corridor.
Short- or long-term gains or losses to hunters.	Positive impact on some wildlife would improve hunting; negative impact on other wildlife would detract from hunting success.
Short-term losses of angler access to streams.	Project-related activities would affect an indeterminate number of anglers in all areas.
Potential short-term loss of marine recreation along Lynn Canal	A large oil pipeline leak or rupture could enter Lynn Canal and affect marine recreationists and tourists.
Potential short-term loss of freshwater angling and related water play.	An oil pipeline leak or rupture would affect water-related recreation.

ECONOMIC CONDITIONS

Unavoidable adverse impacts during construction could include strains on housing and public services in small rural communities and nuisance impacts from crowded conditions. During operation, a major fire or oil spill could cause unavoidable strains on fire protection services and damage to property. Abandonment would entail the loss of property tax revenues to local governments along the route.

Table 8.2.5-7 indicates the unavoidable adverse impacts along the pipeline route.

SOCIAL CONDITIONS

Table 8.2.5-7 summarizes the unavoidable impacts on social resources.

TABLE 8.2.5-7 UNAVOIDABLE ADVERSE IMPACTS--ECONOMIC AND SOCIAL

	Industry and Employment
Construction	Reduced tourist activity generally supplanted by construction-related activity.
	Fiscal
Construction	Increased expenditures of local governments not compensated by increased revenues during construction phase.
Operation	Increase in property base.
Abandonment	Loss of property tax base.
	Infrastructure (Skagway)
Construction	Lack of adequate housing. Additional demands on police force from civil incidents and traffic congestion. Loss of tourism from closure of railroad.
Operation	Population increase of 460 people. Lack of housing. Large oil spills would interrupt ferry and tour ship service.
Abandonment	Loss of employment for 114 people.
	Social Well-Being
Construction	Population density will double. Housing conditions overcrowded.
Operation	Population density increase of 63 percent above present conditions.
Abandonment	None.
	Quality of Life
Construction	Change in lifestyle of Skagway. Congestion in streets and public facilities. Change in historic quality of perceived aesthetic setting.
Abandonment	None.

8.2.6 THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The major objectives of the proposed project are to provide a reliable short-term and possible long-term supply of crude oil to refineries in northern tier and inland states, and to provide an improved means of distribution of Alaskan crude oil to the lower 48 states. The benefits would accrue primarily to crude oil producers, refiners, and NEC, and secondarily to consumers of refined products.

Major short-term trade-offs resulting from the proposal would be the loss of existing environmental and cultural values in Skagway caused by the expansion and use of harbor by crude oil tankers and barges. There would be a short-term commitment of land for the onshore storage facility and a permanent commitment for the pipeline corridor along the route of the historic White Pass-Yukon Route railroad and through Klondike Gold Rush National Historical Park. There would be a risk of environmental damage from oil spills, fires, and explosions. Intermittent periods of air quality degradation would be experienced in the Skagway area.

For the purposes of this discussion, short-term is the 20-year lifetime on which the project economics have been based. The long-term is the period beyond 20 years.

The proposed tanker unloading facility, including tanker maneuvering area, would require about 40 acres. Approximately 2.5 land acres by the harbor would be occupied by the port facility. The onshore storage site would occupy 73 acres of land, of which 62 acres are already used as a storage facility. Including the 33 acres needed for the unloading pipeline and port facility access road, total land requirements would be about 116 acres.

Port Facility

The short-term use of Skagway harbor would have the long-term effect of converting one acre of shoreline to an access road. Approximately 2.5 acres of the harbor would be occupied by the berth. Commitment of harbor resources to the proposed project could deter the development of additional deep draft piers which could result in cumulative long-term impacts. The port facility might continue to operate beyond the short-term. Other deep draft uses of the harbor might be precluded until after abandonment of the proposed project. A major, permanent alteration of the visual quality of the shoreline would result from the unloading pier and the 2,000 foot road extension. These may also change erosion rates on the cliff and create a risk of rockslides.

Skagway is not advantageously located either physically or economically for development of refineries or petrochemical plants. Therefore, short- or long-term induced changes in petroleum-related industries in the port area are not expected.

During construction of the port facility degradation of air quality and increased noise would occur locally. It is not anticipated that any state or Federal air quality standards would be exceeded during the project life.

Any oil spill from tankers, bunker fuel barges, or unloading facilities would use environmental resources in excess of those used in normal project operation. Minor operational spills would be relatively frequent, resulting in local reduction of seawater quality for short time periods. The cumulative effect of such spills would result in some displacement of marine plants and animals and in long-term reduction of productivity in local areas. A spill of over 10,000 barrels is not expected to occur during the life of the project. However, if one did occur it would affect marine resources, water quality, shorelines, shoreline structures, boats, waterfowl and eagles. The impacts would be significant; most would be of relatively short duration. Some residual adverse effects on marine water quality and organisms, and on shorelines, would probably continue into the long-term.

Onshore Storage Facilities

The short-term use of 73 acres for the storage facility and 33 acres for the unloading pipeline would entail long-term commitments of environmental resources. The land could be made available for other commercial, industrial, or residential use when the project was abandoned. The topography and soils of the site would be permanently altered. These changes could limit future uses. Ground water quality would be degraded for years if a major oil spill occurred.

During the estimated 18-month construction period for the onshore storage facility, air quality would be reduced locally and noise could be an annoyance to nearby residents. It is not expected that any federal or state air quality standards would be exceeded. During the short-term there would be continuous hydrocarbon emissions from the storage tanks. These apparently would not cause a significant increase in ozone concentrations. The onshore storage facility would cause a deterioration of visual quality for the life of the project. The initial proposed throughput of 500,000 barrels per day would require eight storage tanks each 62 feet high with a diameter of 250 feet.

Pipeline System

A minimum of 135 acres of land would be disturbed by construction of the pipeline and related facilities. About 100 acres would be needed for the life of the project for operation and maintenance of the pipeline. Building construction and tree growth would be prohibited within the corridor; however, herb and grass species would be encouraged.

The commitment of land resources to the pipeline right-of-way would not affect either short- or long-term opportunities over much of its length. However, aesthetic appreciation of the historic White Pass-Yukon Route through Klondike Gold Rush National Historical Park would be permanently reduced. The proposed pipeline route would almost entirely follow existing cleared corridors. However, additional clearing and excavation would be required. Powerline clearings would be enlarged in two segments, each of less than a mile. With the possible exception of historic White Pass City, clearing would not provide new access to extensive undeveloped areas.

The proposed pipeline route would be an addition to an already-established utility corridor. Reversal to a natural state would be unlikely after the project was abandoned.

Topographical changes along some of the proposed pipeline route would be modest. However, the excavation of a right-of-way of workable width in steep terrain would result in a long-term alteration in topography and a permanent reduction in visual quality. Aesthetic qualities as seen from Brackett Trail, the Carcross highway, and White Pass City would be impaired along the railroad.

Construction of the pipeline system would have local adverse impacts on air quality, noise levels, soil, vegetation, wildlife, water quality, fish in freshwater streams, and recreational activities during the construction period and in some cases for a year or two afterwards. Significant impacts on long-term maintenance or productivity of these resources are not expected, with the exception of long-term productivity to some wildlife resources.

Cultural resources along the pipeline corridor would in most cases be excavated by professional archaeologists prior to construction. Acquisition of cultural resources would be a short-term gains obtained in exchange for the loss of other potentially greater long-term values. In other cases cultural resources would probably be destroyed by construction equipment resulting in permanent loss, particularly within Klondike Gold Rush National Historical Park.

A variety of social services would be required in Skagway during the pipeline construction period. None would require significant trade-offs or constrain long-term opportunities.

Construction wages and property taxes from the pipeline and its appurtenances would provide economic benefits. This could result in significant beneficial impacts during the life of the project. Temporary suspension of rail service during construction would increase highway tourist travel and freight hauling. A possible permanent loss of freight hauling to trucking would jeopardize continued rail service and its attendant revenue.

Minor pipeline leaks are expected to occur frequently throughout the life of the project, requiring the commitment of resources in the local area for a short time. Spills could have long-term adverse effects. Oil spills on land and in streams can result in degradation of ground water quality for an unknown but presumably long time.

Oil spills at stream crossings would result in degradation of water quality and destruction of fish and other freshwater organisms and their habitat. The effects would be carried downstream from the spill area for a distance dependent upon spill size and stream characteristics. In some areas a stream crossing spill could result in damage or destruction of marine resources. Damage from minor spills would probably be ameliorated within a few years.

A major pipeline oil spill is not expected to occur during the life of the project. If one did occur, the amount and significance of environmental damage would depend on the spill's time, place, and size and the clean-up efforts. The potential for long-term reductions in productivity of the various resources mentioned above would be greater.

In summary, the proposed pipeline project could generate both short-term and long-term adverse and beneficial impacts on various components of the environment. The project would have significant effects on the preservation and enhancement of long-term resource productivity in the greater Chatham Strait and Skagway area. Short-term economic benefits could be exchanged for a changed life style with some risks to present and future recreation, commerce, and possibly health and safety (because of air quality degradation and the potential for major oil spills, fires, and explosions). Some resources would be used along the pipeline system, primarily during construction. These resources, plus those committed to project use for the short-term, would not involve any significant alterations in long-term productivity. The major trade-off involves the risk of damages caused by oil spills, fires, and explosions in exchange for the short-term economic benefits of supplying oil to inland states.

Alaskan Mink

8.2.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The use of finite resources in a manner which precludes their use for other purposes is termed an irreversible and irretrievable commitment of resources. This chapter summarizes and where possible quantifies resources that would be consumed or otherwise lost if the proposal were implemented.

Construction, operation, and abandonment of the proposed port, onshore storage facility, and pipeline system would result in the commitment of many resources. Most of the resources committed would be "used" for the short-term and their loss during that time would be irretrievable. Changes in the environment at the proposed port and onshore storage facilties, along the pipeline route, and at ancillary facilities can be considered irretrievable commitments. In addition to environmental changes, capital, labor, material, and energy would be irretrievably committed to construction, operation, and abandonment.

Beyond these commitments of resources, the possibility of oil spills must be considered. Oil spills would cause changes in the environment and would require commitments of capital, labor, materials, and energy for cleanup. The extent of these commitments would depend on frequency, time, place, and magnitude of the spills.

AIR QUALITY

Air quality and visibility would be irretrievably degraded during the life of the project, particularly in the Skagway area. For aooroximately 3 or 4 days each year atmospheric conditions would allow pollutants to drift from the port facility over part of Skagway, causing sulfur dioxide levels to exceed the Class I maximum allowable limit. This change would be periodic and short-term but not irreversible. Periods of air quality degradation would be irretrievable, particularly in the immediate vicinity of the proposed port. No irreversible or irretrievable commitments of air quality along the pipeline route are anticipated.

SOILS

The development of the onshore storage facility and pipeline would irretrievably commit the soil of about 250 acres for the life of the project. Use for plant propagation would be lost. Construction, operation, and maintenance of new pipeline and maintenance roads or trails, support facilities, runoff holding basins, and tank storage sites would cause a loss of soil productivity for the life of the project and for an undetermined length of time after abandonment. Mixing of the soil profile would retard natural revegetation within the pipeline right-of-way. Soil profiles within the pipeline trench and the areas of excavation would be permanently altered. Soils lost by wind and water erosion during construction, operation, or abandonment would be irretrievable.

Oil-Spill Risk Analysis

An oil spill could cause significant and irretrievable loss of soil productivity for several years. With time and careful rehabilitative efforts, soil productivity might be reestablished.

AQUATIC RESOURCES

Construction of the pipeline system would degrade the water quality of numerous streams. This would be largely self-correcting. However, the short term loss of quality would be irretrievable. Degradation of groundwater sources could last for several years. Associated with the loss of water quality would be loss of fish spawning habitat which could be irreversible and extend beyond the life of the project.

Oil-Spill Risk Analysis

An oil spill affecting aquatic resources would be irretrievable. In most areas the loss would be of short duration. However, a longer irretrievable loss of water quality could occur if an oil spill contaminated the ground water. A loss of municipal or domestic use of water would be critical and would last for years.

At certain times and places an oil spill could result in the loss of one or more year-classes of freshwater and anadromous fish species. This would be an irretrievable commitment of fishery resources.

MARINE RESOURCES

Construction of the port would result in the degradation of water quality in Skagway harbor. This loss would be of short duration and irretrievable.

Construction and abandonment would also cause irretrievable loss of marine organisms within the harbor. However, during operation the disturbed areas would be repopulated.

Oil-Spill Risk Analysis

Small chronic spills of crude and fuel oil from tankers and associated vessels are expected and would result in an irretrievable reduction of water quality in a limited area of the harbor and an irretrievable loss of marine life in the immediate area of the port.

A massive oil spill from a tanker accident or pipeline break would cause significant degradation of marine water quality. Restoration to pre-spill quality could be slow, resulting in irretrievable long-term loss of water quality. A massive spill would also result in the irretrievable loss of marine life. However, such a loss would be replaced over the long term. Marine mammals, especially the endangered humpback and

Pacific gray whale populations, fish, and birds would be affected. A massive spill in Chatham Strait or Lynn Canal would irreversibly degrade the many miles of shoreline used by many mammals and birds.

TERRESTRIAL VEGETATION

Clearing prior to construction of the proposed onshore storage facility would result in the loss of about 40 acres of riparian vegetation which would be irretrievable if the area were converted after abandonment to industrial or commercial uses. Construction of the pipeline would require a maintained, cleared right-of-way.

Oil-Spill Risk Analysis

An oil spill could result in irretrievable loss of vegetation which would be related to irretrievable loss of soil productivity. Reestablishment of vegetation could be expected to take at least one year.

TERRESTRIAL WILDLIFE

Construction of the pipeline would degrade wildlife habitat throughout its length for the duration of the project. Following abandonment and subsequent revegetation, animals would be expected to return.

Oil-Spill Risk Analysis

Oil spills and cleanup efforts would result in the loss of animals from oiling, toxicity, and the loss of habitat.

CULTURAL RESOURCES

Each cultural resource site has unique and nonrenewable values. Loss of a cultural resource is a loss of opportunity to learn more about human prehistory or history. Known cultural resources can often be salvaged before construction. However, loss of sites would be irretrievable. Once construction is underway cultural resources not previously identified could be destroyed before they were recognized and construction halted. Unrecovered cultural resources would be classed as an irreversible and irretrievable commitment.

Losses of paleontological resources would be similar to losses of archaeological and historic resources. Their values are scientific, educational, and aesthetic.

Oil-Spill Risk Analysis

Because of low probability of large oil spills and scarcity of cultural resource sites, expected damage to cultural resources is minimal. If an oil spill were to occur in the vicinity of a site cleanup efforts would probably cause the greatest irretrievable loss. Use of machinery or hand tools could also cause the irretrievable losses.

VISUAL RESOURCES

Construction of the port and onshore storage facilities would irreversibly alter views in Skagway. The storage tanks and pump station would be considered a visual intrusion. The 100-foot high stack of the generating station would also be a visual intrusion.

Construction of the pipeline would result in the irretrievable loss of visual resources across the pipeline route. The visual contrast would be greatest through forests.

Oil-Spill Risk Analysis

A marine oil spill could result in major degradation of visual resources in the Skagway area. An irreversible short term loss of visual resources would occur as a result of an oil spill in Lynn Canal or Chatham Strait.

LAND USE, TRANSPORTATION, AND UTILITY NETWORKS

Construction of the port at Skagway would preempt 2.5 acres in the harbor. Following abandonment and removal of the port this water area would be available for other uses.

Construction of the onshore storage facility would result in the loss of about 73 acres of forest lands. Other uses, including potential residential development, would be precluded. These losses would be irreversible if other industrial uses followed abandonment.

The pipeline right-of-way and pump station site would be irreversible land-use commitments for the life of the project. These installations would restrict expansion of timber production into transportation or utility corridors. The pipeline corridor would, when abandoned, probably continue as a railroad transportation corridor into the long term.

Oil-Spill Risk Analysis

Oil spills would disrupt land use and transportation networks for a short time.

RECREATION

Construction of the proposed pipeline would cause irretrievable losses of recreational resources in certain areas. The cleared right-of-way would irreversibly change areas valued for their beauty, solitude, or other natural qualities. Displacement of wildlife or loss of fish would also irretrievably affect recreation.

Oil-Spill Risk Analysis

Oil spills and cleanup efforts would result in the loss of recreational resources, including tourism. In most instances the loss would be short-term; however, loss of fishery or marine resources could cause an irretreivable long-term loss of both commercial and sport fisheries.

ECONOMIC CONDITIONS

The proposed construction and operation of the port and onshore storage facilities would result in major irretrievable and irreversible economic changes in Skagway. A new industry of oil transshipment would become a major contributor to the local economy, with an impact similar to that of the railroad.

If the crude oil delivery system was fully developed as described in the proposed action it irreversibly commit to use approximately 14 miles of 36-inch steel pipe in Alaska. The tons of steel used in constructing the port and onshore storage facilities would likewise be irreversibly committed. A major portion of this steel could be salvaged upon termination of the project; non-salvageable steel and other natural resources would be irretrievably lost.

Construction, operation and abandonment of the proposal would result in irretrievable changes in Skagway. For the most part these changes would be short-term during the construction stage. The project would probably result in long-term commitments of existing refineries in the market area to the continuation of their operations.

Implementation of the project would irretrievably commit up to 637 workers for various periods of time during the construction, the equivalent of 675 man-years of labor in direct employment. Once construction was finished, permanent employment of 114 persons would be irretrievably committed to operate the system.

Table 8.2.7-1 shows the net energy balance estimated by NEC over the 20-year life of the project.

TABLE 8.2.7-1 NET ENERGY BALANCE - SUMMARY
(20-Year Project Life)

	Energy Equivalent (Million BTUs)
Crude petroleum delivered	20,553,953,000
Energy consumption	
Tanker fuel	287,072,387
Main line liquid fuel pumping	148,943,323
Construction materials	28,049,776
Other	8,233,135
Total consumption	472,298,622
Net energy delivered	20,081,654,379

Source: NEC 1979

Oil Spill Risk Analysis

A major oil spill would result in the irretrievable commitment of human and material resources for cleanup efforts. It would also represent a major loss of revenue to the fishing industry operating in Chatham Strait and Lynn Canal.

SOCIAL CONDITIONS

To some residents in the area, the project's construction would irretrievably decrease the quality of life. Possible losses of life or limb from accidents during construction, operation, or abandonment would be irretrievable losses. Because of the size of Skagway, the use of the social facilities of the city would constitute a large impact during the short term construction period. Generally speaking, rents would be higher. This would have a prolonged impact.

Oil-Spill Risk Analysis

An accident leading to an oil spill could cause a significant and irretrievable loss in the quality of life because of the importance of the marine environment to the citizens of the community. Degradation of the human environment through contamination and possible fire and explosion would be an irretrievable and irreversible loss.

Kitimat Pipe Line Ltd.

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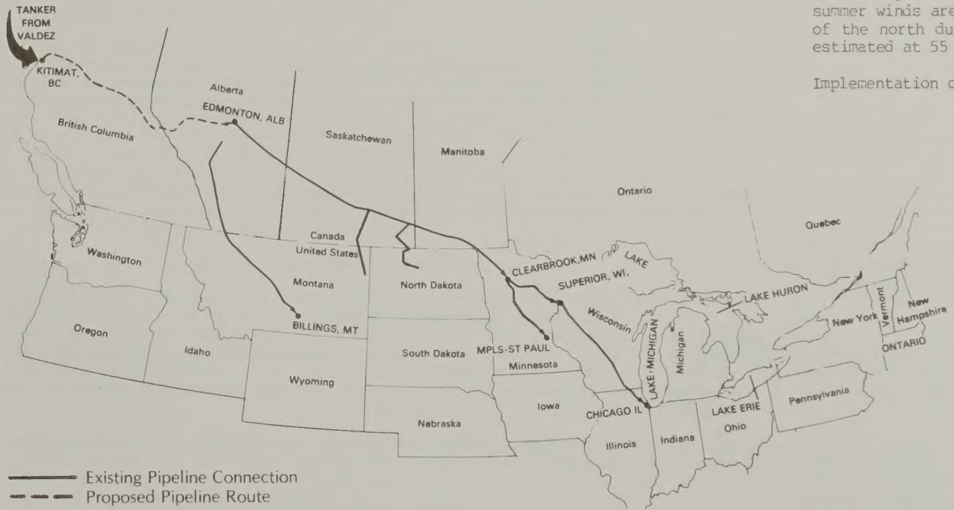
8.3 KITIMAT PIPE LINE, LTD. PROPOSAL

8.3.1 DESCRIPTION OF THE PROPOSAL

As shown in figure 8.3-1 and discussed in chapter 1, Kitimat Pipe Line, Ltd. (KPL) proposes to construct and operate a common carrier crude oil transportation system from Kitimat, British Columbia to Edmonton, Alberta, Canada.

As discussed in the Introduction, this analysis will be limited in accordance with the provisions of Executive Order 12114. Material presented is based on KPL's submission to the Canadian National Energy Board in December 1976, and its application on December 8, 1978, to the Secretary of the Interior under Title V of the Public Utility Regulatory Policies Act of 1978.



Kitimat Pipe Line Ltd. Proposal

8.3.2 ENVIRONMENTAL ANALYSIS

PORT AND ONSHORE STORAGE FACILITIES

CLIMATE

The town of Kitimat has a maritime climate dominated by the Pacific Ocean, characterized by warm summers, and relatively mild winters, with very heavy precipitation. Average daily temperatures range from a low of 20°F in January to a high of 70°F in July, with extremes of -13°F (December) and 97°F (July). Annual precipitation averages about 94 inches; two-thirds of this moisture falls from October through February. Average snowfall is 211 inches.

Prevailing winds blow north and south, parallel to the Kitimat Valley. During the summer winds are predominately out of the south, averaging 7.2 miles per hour and out of the north during winter, averaging 12.4 miles per hour. Maximum winds have been estimated at 55 miles per hour.

Implementation of this project would have no impact on climate.

AIR QUALITY

Kitimat has air quality problems, with occasional poor ventilation. Inversions are common in winter. A pulp mill and an Alcan aluminum plant emit moderately high levels of sulfur dioxide. Fluoride standards are frequently violated and particulate standards are sometimes exceeded. However, no quantifiable data are currently obtainable.

The proposed port and onshore storage facilities would add sulfur dioxide and introduce major new hydrocarbon emissions. The quantity of emmissions is not known.

NOISE

No information is currently available.

TOPOGRAPHY AND GEOLOGY

The proposed port and onshore storage facilities are located about 6 miles southwest of the town of Kitimat, along the western shore of Kitimat Arm. The terrain is characterized by occasional narrow beaches, moderately high sea cliffs, and steep slopes rising 2,000 feet above the shore, sometimes interrupted by topographic terraces. Offshore, the subbottom slope extends to depths of over 500 feet with 100 percent slopes.

Topographic impacts resulting from implementing the proposed project would consist primarily of permanent landscape alterations.

Impacts to the geologic material would consist of changes to its physical characteristics (cementation, porosity, permeability, etc.) as a result of construction activities, including blasting, and excavation. However, no specific information concerning the amount of material removed and the degree of change in its physical characteristics is presently available.

The proposed port and onshore storage facilities are located near the boundary between seismic zones 2 and 3 (as established by the Canadian National Building Code), where expected earthquake damage would be from moderate to major. Available data indicate that the Kitimat area has a low level of seismic activity and no active faults. Consequently, risk from surface ground movement is considered to be low. However, the presence of unconsolidated material, both onshore and offshore, indicates that the risk from ground shaking is relatively high, particularly along the steep submarine slopes. While there is a possibility of shoreline damage due to a seismic sea wave, the 60-mile distance from the Pacific Ocean and general NE orientation of Kitimat Arm would dissipate wave height and velocity sufficiently to protect the shoreline.

Potential slope instability is found about 4,000 feet north of the proposed port and onshore storage facilities at Moon Bay, the site of a large landslide that damaged portions of Kitimat harbor in 1975; near the southern docksite (possibly an inactive rock slide); and along the steep slopes offshore.

Impacts to the project would largely occur as a result of slope instability which could be triggered by ground shaking, construction activities including blasting, strong winds, or heavy precipitation. Slope failure could trigger a sea wave, resulting in significant or critical impacts to the port and/or onshore storage facilities, possibly causing an oil spill.

SOILS

Soils at the port and onshore storage facilities consist of a relatively thin zone of sandy silt and gravelly clay generally thickest over sedimentary deposits and practically non-existant over crystalline bedrock. The soil is capped by a mantle of organic debris of varying thickness.

In general, the soil and organic zones are saturated due to high precipitation. Surface runoff is limited to areas of exposed bedrock or soil and occasionally to the soil/bedrock interface where downward percolation of water is impeded.

Implementing the proposed project would probably cause soil erosion and surface runoff. However, there is no information presently available to quantify these impacts.

AQUATIC RESOURCES

No information is currently available.

MARINE RESOURCES

Sea Leg

Tankers delivering crude oil to Kitimat would cross about 821 miles of open sea from Valdez, Alaska and over 10,000 miles from the Middle East or Southeast Asia. They would approach Kitimat through a 60-mile-long fiord, consisting of a broad, 600-foot deep estuary (Dixon Entrance) and a series of deep, narrow channels and inlets. Tidal currents are moderately strong near the ocean end of the fiord, where velocities reach 6 or 7 knots during both flood and ebb. Near the approach to the terminal (Douglas Channel) currents range between .5 knots at flood and 1.5 knots at ebb. While navigation of the fiord can be difficult at times, the widths of the approach channels are considered adequate for the transit of large oil tankers. No serious navigational hazards are anticipated.

Physical Components

As noted above, maximum tidal currents in Kitimat Arm are relatively low. The higher ebb velocity is due to the discharge from the Kitimat River at the head of Kitimat Arm. Current velocities near Kitimat and the terminal facilities are even lower--less than one knot. Expected wind-generated wave heights are generally low, at a maximum of 7.9 feet. Waves caused by landslides, while uncommon, have occurred in the past and could happen again. Greatest expected wave heights from landslides have been estimated at 11 feet.

There is currently no data available concerning the quality of the marine water. A quantitative oil spill risk analysis has not been made.

Biological Components

Chatham Sound, Dixon Entrance, Hecate Straits, and the inner passages are all highly productive, supporting herring, ling cod, northern anchovy, English sole, Pacific cod, sculpin, starry flounder, and red snapper fisheries. Important anadromous fish include five species of salmon and steelhead trout. Sea otters, hair seals, fur seals, and sea lions frequent the sounds and straits.

Waters are less productive within the steep walls of Douglas Channel, although the small river estuary at the head of the channel is part of the Pacific Flyway, a breeding ground for many species of migratory ducks and geese. Common waterfowl and shorebirds include cormorants, grebes, puffins, gulls, sandpipers, sanderlings, killdeer, and plovers.

Anticipated impacts to physical and biological marine resources resulting from the movement of tankers and operation of the port and onshore storage facilities are expected to be minor, with the exception of a major oil spill, which could cause serious and long-term harm to biological resources such as intertidal fisheries and birds. However, impacts are not expected to be irreversible.

TERRESTRIAL VEGETATION

The Kitimat area is situated in the Coastal Western Hemlock Zone and is heavily forested with native trees. The port and onshore storage facility is wilderness with essentially no access. No other information is currently available.

TERRESTRIAL WILDLIFE

No information is currently available.

CULTURAL RESOURCES

While there are numerous archeological and historical sites in the region, there is presently no information obtainable concerning their location. Consequently, an assessment of impacts is not possible.

There is no information available pertaining to fossil sites.

VISUAL RESOURCES

No information is currently available.

LAND USE

Existing land use in the Kitimat area is dominated by logging and the Alcan aluminum smelter. There is some use of Kitimat harbor by commercial fishing boats. The site of the port and onshore storage facilities is wilderness with no access. The pattern of land ownership in the area is not known.

Implementation of the project is not expected to result in significant impacts on land use.

TRANSPORTATION AND UTILITY NETWORKS

Kitimat is served by a commercial barge system from Vancouver, B.C., a spur line of the Canadian National Railway, and a good road to the interior of British Columbia. A commercial airport at Terrace, 30 miles away, provides service to Vancouver three times a day. Kitimat also has telephone, telegraph, and electrical service. The terminal and onshore facilities, however, are located in a wilderness with no transportation or utility service.

A road would be required to provide access to the port and electrical power would be required to operate the facilities. There would not be a significant impact on the transportation and utility networks.

RECREATION RESOURCES

Sport fishing and boating are the only major recreational activities in the Kitimat area. There is, however, no information readily available pertaining to the number of fisherman-days, total catch, or number of small craft in the district.

Operation of the port facilities would probably have a minor impact on recreation. A large oil spill could adversely affect fishing for one or more seasons.

SOCIAL AND ECONOMIC CONDITIONS

There is no information readily available pertaining to the present and projected social conditions in the Kitimat area--e.g., population growth--and anticipated impacts resulting from construction and operation of the port and onshore storage facilities.

Income in the Kitimat area is derived from commercial fishing, logging, pulp manufacturing, and aluminum processing. Information pertaining to the dollar value derived from these industries is not available. As the Kitimat fleet fishes outside of Kitimat Arm, operation of the port facility would have little impact upon it. The logging industry would be affected by an oil spill which contaminated logs stored in the harbor.

No impacts to the aluminum smelter are anticipated.

PIPELINE SYSTEM

CLIMATE

The proposed pipeline route would cross two climatic regions. From Kitimat to approximately pipeline mile 75 the pipeline would traverse the marine west coast region, which is characterized by mild winters and cool summers and has heavy annual rainfall. Beyond pipeline mile 75 the pipeline would primarily traverse the undifferentiated highlands climatic region, which is characterized by cold, wet winters and relatively dry summers. Table 8.3-1 shows climatic characteristics by pipeline segment.

TABLE 8.3.2-1 CLIMATIC SUMMARY BY PIPELINE MILE

Route Segment (pipeline mile)	Total Annual Precipitation (inches)	Total Annual Snowfall (inches)	Seasonal Characteristics	Growing Season (days)
0-75	65-262		Mild winters Cool summers	162-236
75-300	22-44	16-75	Severe winters Dry, warm summers	162-186
300-340	16-25	60-110	Very severe winters Dry, warm summers	162-186
340-450	22-67	76-265	Cold winters	
450-470	14-22	30-70	Cold, Dry winters	
470-505	12-23	47-123	Very cold winters Dry summers	
505-550	13		Dry summers	
550-750	12-20		Dry summers	150-169

Source: KPL 1976

Construction and operation of the proposed project would have no known effects on climate. Adverse impacts on environmental components could be minimized by scheduling construction activities according to seasonal climatic conditions. For example, ice fog caused by combustion emissions in cold weather could be reduced by concentrating construction activities during warmer weather.

AIR QUALITY

Emissions from construction activities and fuel combustion during the construction and operation phases of a pipeline cannot be prevented. These emissions could affect the ambient air quality in the vicinity of the pipeline as well as the 10 pump stations. Particulate emissions would result from land clearing, excavating, laying foundations, and related trucking activities. Gaseous emissions would result from combustion of fossil fuel. Such emissions would be temporary, intermittent, and spread over a relatively wide area. Significant impacts to biological communities are not expected.

Ice fog is a form of pollution unique to northern latitudes. Under certain cold conditions, water vapor emitted as a byproduct of fuel combustion will condense on hydrocarbon nuclei and immediately form ice fog. Visibility in the immediate vicinity of construction areas and operating pump stations could be affected. Overall impacts would be temporary, intermittent, and dispersed over a wide and remote area.

NOISE

Pump stations would be the primary source of noise associated with the completed pipeline. The diesel-powered stations would be considerably noisier than electric ones. The distance at which these stations would become inaudible depends upon the amount of noise controlled by enclosures and exhaust silencing systems, and on surrounding topography, ground cover, meteorological conditions, and background noise levels. The noise level for a typical diesel pump station has yet to be determined, but it is estimated that it would become inaudible within 4 miles under worse-case conditions (no exhaust silencing and extremely low background noise levels). On the other hand, if noise control measures were incorporated into the design of the stations and other parameters noted above were favorable, the noise might be inaudible at distances of 1,000 feet or less. Field measurements or a comprehensive review of the literature would be required for a more accurate definition of the impacts of noise.

Since pump stations would not be located in the vicinity of communities or individual dwellings, noise would be heard only by recreationists and wildlife. In wilderness areas background noise levels can extend down to the threshold of hearing. Pump station noise could detract from the use of nearby areas for hiking, canoeing, and other recreation. Since the zone of noise around each station would be relatively small, it is unlikely that there would be any serious consequences to wildlife. Pump stations would be situated to avoid any unique breeding, wintering, or migration areas.

Pump stations would be designed to minimize noise output and local topography and vegetation would be considered in locating stations.

The noise of construction equipment would be regulated by the contractor. Major access routes during construction would be chosen to bypass communities and individual dwellings where possible.

Sensitive areas and times of year would be identified in order to minimize impacts of noise on wildlife. Construction schedules would be modified, different equipment used, or sensitive areas bypassed. Blasting would be done with caution. Sensitive areas adjacent to the proposed pipeline would be identified so that blasting and other loud noises could be minimized, especially at critical times of the year, e.g., nesting grounds of waterfowl during breeding season.

TOPOGRAPHY AND GEOLOGY

The pipeline route would cross five distinct physiographic subdivisions between Kitimat and Edmonton. The Coast Mountains and Hazelton Mountains would be crossed by the proposed pipeline from pipeline mile 0 to 106. The Coast Mountains lie along the mainland coast of British Columbia from just north of Vancouver to the northern boundary of the province. Near Kitimat they are composed largely of granitic intrusive rocks. The Hazelton Mountains to the east are considered part of the central plateau and mountain area.

The Interior Plateau (pipeline mile 106 to 341) is a major physiographic subdivision of British Columbia which, at the latitude of Prince George, extends from the Coast Mountains to the Rocky Mountains. Along the route of the proposed pipeline, the Interior Plateau is characterized by low, rolling hills separated by broad valleys into which rivers have cut channels from a few feet to a few hundred feet deep. During Pleistocene glaciation the Interior Plateau was occupied by the Cordilleran ice sheet which deposited a nearly continuous mantle of glacial till over its surface.

The Rocky Mountain Trench (pipeline mile 341 to 452) extends northwest from the 49th parallel to near the Yukon border. The pipeline route would follow the trench from a few miles east of Purden Lake to the point where the Fraser River enters the trench from the east at Tete Jaune Cache. In this area, the Rocky Mountain Trench is a straight, flat-bottomed valley, 4 to 5 miles wide, bounded on the southwest by the Caribou Mountains and on the northeast by the Rocky Mountains.

The pipeline route would cross the Rocky Mountains (pipeline mile 452 to 551), which are composed of sedimentary rocks, through Yellowhead Pass, the route of the Canadian National Railway, highway 16, and the Trans Mountain Pipeline.

The Rocky Mountain foothills (pipeline mile 551 to 556) form the eastern boundary of the Rocky Mountains. Although they reach similar elevations, they have different underlying bedrock and topographic form. The proposed route through the foothills resembles the route farther east on the Alberta Plains (extending to pipeline mile 759). Both the Alberta Plains and the foothills are underlain by sedimentary rocks.

Principal geologic hazards to construction and operation of the proposed pipeline would be earthquakes and faults, river scour, rockfalls and snowslides, and slump landslides.

Kitimat is in earthquake and fault zone 3, the zone of highest risk. Terrace, about 35 miles north of Kitimat, is on the boundary between zone 3 and zone 2. Smithers, about 50 miles east and slightly north of Terrace, is in zone 2, and Prince George is in zone 1. The boundary between zone 1 and zone 0 lies east of the British Columbia-Alberta border.

River scour can cause lateral shift or deepening of the river channel, which would affect the integrity of the pipeline. Rivers west of Telkwa Pass divide would be the most vulnerable and lateral migration would most likely occur in the Athabasca River bed.

Rockfalls and snowslides would not damage the buried pipeline unless they were very large. The area of greatest risk would be Telkwa pass, between pipeline miles 66 and 72.

Slump landslides would be a particular hazard where the pipeline crossed preexisting slides. These areas would be avoided when possible. Other areas avoided would be riverbanks which appear to be unstable due to active erosion and sidehill slopes in glacial lake silts and clays.

Exposure to geological hazard areas would be minimized by construction design.

SOILS

Soils along the pipeline route derive from parent material deposited primarily during or after Pleistocene glaciation and include glacial till, silts and clay deposited in glacial lakes, and sand and gravel deposited by glacial meltwater, as well as soil materials deposited by present day rivers and streams.

Soil series along the pipeline alignment are found in soil survey reports published between 1962 and 1973.

Non-agriculture soils occur between pipeline miles 0 to 100 and miles 310 to 550 in British Columbia.

Agriculture soils occur along the pipeline route between Telkwa and Prince George in British Columbia and between Peers and Edmonton in Alberta. Some of the best agricultural soils are the degraded black soils and the better-drained Grey Wooded soils, including the Hubalta and Vanderhoof series. Other soil series rated fair to good agriculturally are Maywood, Codesa, Tolman, Carvel, Winterburn, Malmo and Ponoka.

Approximately 5,565 acres within the pipeline right-of-way plus the acreage occupied by 10 pump stations and numerous stockpile areas would be disturbed and rendered vulnerable to erosion. Erosion would be of particular concern at river crossings where the addition of soil particles to streams would degrade water quality.

Pipeline construction would disturb surface drainage patterns, cause ponding of surface water and interfere with or modify groundwater. Excavation of the pipeline trench would alter the natural layering of the soil and modify the physical and chemical composition of the surface. Construction would also reduce crop yields and plant growth by depositing unfertile subsoil in or on the topsoil and compacting the surface; fertile topsoil would be lost from accelerated erosion.

Operation of the pipeline would pose the possibility of oil spills from pipe leaks or ruptures. Spills from a new pipeline would be infrequent but could have significant impacts on the soil depending on size of spill, location, topography, soils, vegetation, and other conditions. Oil spill frequency rates and impacts on the soil are discussed in the Environmental Impacts chapter.

Impacts on the soil could be mitigated by restoring natural drainage patterns; by stockpiling topsoil and restoring it to its natural position; by deep plowing, discing, or ripping compacted areas; by revegetation of disturbed areas; and by expedient cleanup of oil spills and restoration of spill areas.

AQUATIC RESOURCES

The proposed pipeline route would cross more than 30 rivers and streams one or more times and would pass within 2 miles of numerous lakes and streams. Some of the more important streams are:

Little Wedeene River	(pipeline mile 9)
Wedeene River	(pipeline mile 10)
Williams Creek	(pipeline mile 36)
Telkwa River	(pipeline mile 95)
Bulkley River	(pipeline miles 112, 131, 143)
Stellako River	(pipeline mile 203)
Nechako River	(pipeline mile 222)
Fraser River	(pipeline miles 295, 421, 460, 470)
Athabasca River	(pipeline mile 547)
McLeod River	(pipeline mile 629)
Pembina River	(pipeline mile 683)
North Saskatchewan River	(pipeline mile 744)

Impacts on aquatic resources could result from reductions in water supply from low flow streams by upstream withdrawals during pipeline construction for pipe testing and similar nondomestic uses; stream flow interference and sedimentation of water courses from clearing, excavating, or backfilling during at stream crossings; introduction of oil, gas, rust or other toxic substances into the water and introduction of sewage, garbage, or debris to streams.

Any of these could degrade water quality or quantity and have major impacts on human and animal health and on sport and commercial fisheries.

Impacts on fisheries would include the following:

1. habitat alteration
   - disturbance of fish spawning beds
   - obstruction of fish migration
   - decreased oxygen levels in watercourses from increased silt and sediment loads and from fertilizer or sewage
   - loss of shade over streams which could in increase mortality incubating fish eggs
2. pollution hazards
   - increased silt and sediment loads
   - toxic chemicals, rust, and oil from building, flushing, testing, cleaning, and maintaining the pipeline
   - waste, sewage, and debris disposal
   - storage and handling of bulk fuels, lubricating oils, and chemicals at storage facilities, pump stations, and construction camps
   - pipeline breaks
   - blasting (shock waves)
3. Increased harvests
   - greater access to fishing by construction and maintenance personnel, local residents, and tourists

Potential impacts can be minimized by careful design and construction practices which would include:

- completion of stream crossings in accordance with appropriate regulations
- avoiding construction within 300 feet of the high water mark of a stream, lake, or reservoir where possible
- allowing a minimum 30-foot leave-strip of natural vegetation between any parallel or adjacent pipeline clearing and the banks of salmon-bearing waterways
- minimizing conflict with fisheries when constructing stream crossings
- providing for temporary bridging where possible when clearing right-of-way in order to avoid interference with salmon migration and to protect spawning grounds
- working in a manner that would not erode silt into streams, rivers, lakes, and reservoirs
- providing for fish passage to avoid impeding upstream migration
- blasting in an approved manner in any waters inhabited by fish
- observing regulations when taking water from streams, lakes, or reservoirs to test the pipeline; treating the water to remove impurities; discharging the water in a manner and at a location that will minimize effects on fish; screening water intakes in fish-bearing waterways
- provision of water bars, cross drains, culverts and surface vegetation along pipeline right-of-way to reduce erosion and silt
- inspecting all stream crossings during operation.

Procedures for dealing with operational oil spills would be contained in the contingency plan.

The design of pump stations would provide:

- fuel storage areas located away from waterways and diked to accommodate the storage tank's contents
- facilities for the disposal of garbage, sewage, and other wastes are so that pollutants do not enter salmon-bearing waters.

TERRESTRIAL VEGETATION

The first 75 miles of the proposed route (Kitimat to Telkwa Pass) would pass through the Coastal Western Hemlock Zone, which is characterized by mild winters and cool summers. Precipitation is from 65 to 262 inches per year; up to 38 percent is snow. Forests of mature timber are dense except for openings created by bogs, flooding, burns, or logging. Greatest wildlife habitat variability is found at the edges of forest openings or along lakeshores. The pipeline route from pipeline mile 75 at Telkwa Pass to pipeline mile 300 at Prince George would pass through the Caribou Aspen, Lodgepole Pine, Douglas-fir Zone, which is characterized by severe winters and dry, warm summers. Annual precipitation is from 14 to 22 inches; snowfall is from 16 to 75 inches. From pipeline mile 300 to 340 the route would cross the southern end of the Subboreal Spruce Zone, which is slightly colder and wetter than the Caribou Aspen, Lodgepole Pine, Douglas-fir zone, and has considerably more snowfall. Precipitation ranges from 16 to 25 inches; snowfall is 60 to 10 inches. This portion of the route passes through mature forest of mixed spruce and fir, with pine and aspen on drier sites. Forest cover is interrupted by numerous large clearcuts.

From Kenneth Creek (pipeline mile 340) to Small Creek (pipeline mile 450) the proposed route would pass through the Interior Western Hemlock Zone, which has annual precipitation of 22 to 67 inches with 72 to 165 inches of snow. The route would travel the length of this narrow zone which lies in the lower elevations of the Rocky Mountain Trench. The route would contact the Interior Douglas-fir Zone for 20 miles between Small Creek and Robson Park boundary. The Interior Douglas-fir zone is warmer than the others discussed in this section. Annual precipitation is 14 to 22 inches with 30 to 70 inches of snow. Lower precipitation produces a more open forest canopy and development of a more extensive shrub understory.

From pipeline mile 470 to 505, the proposed route would travel through the Boreal White and Black Spruce Zone, where the climate is very cold with 12 to 13 inches of precipitation and snowfall of 47 to 123 inches. Pipeline miles 505 to 550 pass through Montane forest along the low elevation corridor through Jasper Park. While this area contains a variety of habitats, it is considered similar to the Cariboo Aspen Lodgepole Pine, Douglas-fir zone described earlier. The rain shadow effect creates a dry climate here, with about 13 inches annual precipitation and 40 inches of snow. Low snowfall and high habitat diversity make this area attractive to many wildlife species. The remainder of the proposed route (pipeline 550 to mile 750) would pass through the boreal forest, a zone of continous transition from the Montane forest to pine-aspen forest to spruce-aspen forest to aspen forest. Precipitation ranges from 12 to 20 inches a year. Major tree species are aspen, lodgepole pine, white spruce, and black spruce.

Depending on the scale, alteration of vegetation would have an influence on other ecosystem components including wildlife, wind and soil interaction, slope stability, the aquatic environment, and aesthetics. Vegetation along the corridor ditch line, access roadways, and borrow areas would be temporarily removed. Although the total land area affected would not be extensive, the loss of vegetation in the vicinity of potentially unstable slopes and easily eroded areas would be significant in that the integrity of the pipeline and the adjacent physical environment could be affected.. Vegetation in all developed areas used on a continuous basis would be permanently disrupted. The land area affected would be small. All vegetation would be removed at construction camps, stockpile sites, and along temporary roads. Vegetation would be removed to gain access to borrow material.

Pipeline construction, with the consequent increase in human and mechanical activity, would increase the possibility of fire in the area. The greatest impact from a fire would occur in heavily wooded areas.

Some rare plant species might be eliminated in limited areas. Natural revegetation by herbaceous plants and small shrubs would be permitted after construction. Revegetation procedures, including light fertilization would be used to promote quick growth.

TERRESTRIAL WILDLIFE

Wild animals use different habitats at different seasons. Consequently, they vary in their sensitivity to impacts.

Some of the wildlife observed along the proposed route include moose, elk, mule deer, white-tailed deer, mountain caribou, bighorn sheep, mountain goats, black bear, grizzly bear, wolf, beaver, muskrat, mink, Canada geese, swans, mallards, and various other waterfowl.

Major sensitive wildlife areas and the species or habitat that would be affected are:

1. Williams and Trapline Creeks, Clore River (pipeline mile 35 to 55)
    - virgin timber in remote areas
    - grizzly bear
2. Telkwa Pass and Valley (pipeline mile 70 to 90)
    - virgin timber in remote areas
    - grizzly bear, mountain goat, caribou
3. Bulkey Valley to Fraser Lake (pipeline mile 100 to 200)
    - important winter range
    - deer, moose, elk, and sheep
4. Edmonton (pipeline mile 700 to 750)
    - waterfowl breeding and migration area
    - ducks, geese, swans, shorebirds

Clearing and leveling of the right-of-way would remove vegetation, create access into remote areas, and disturb animals, which could result in abandonment of habitat, high mortality, and disturbance of reproduction. Ditching, pipe laying, and backfilling would disturb wildlife and alter the soil and drainage patterns. Flooding or draining low-lying areas could alter productivity.

Revegetation would also affect wildlife, depending on whether natural or exotic vegetation and natural succession or artificial propogation were used.

Construction activity involves a concentration of people and machines in wildlife habitat. There is a potential for high mortality of wildlife if workers are permitted to have guns or dogs in the work area.

Oily wastes from machinery can contaminate aquatic wildlife areas. Oil spills from pipeline breaks could degrade habitats and cause loss of terrestrial wildlife and waterfowl. Sensitive areas are the shoreline of Kitimat Arm, Lake Lakelse, Fraser and Wabamun Lakes, the pothole marshes near Edmonton, and all stream crossings. Impacts at each are potentially high.

Mitigation hazards would include minor realignments within the chosen corridor to avoid direct contact with most of the highly sensitive habitats; timing construction for the least sensitive part of a species' life cycle; requiring that construction specifications include avoidance of potential adverse impacts; and minimization of impacts on wildlife and wildlife habitat in contingency plans for cleanup of oil spills.

CULTURAL RESOURCES

The pipeline right-of-way would parallel existing transportation corridors for much of its length. Archaeological impacts are expected to be minimal along the right-of-way. Sites of support facilities including access roads, pump stations, and material stockpiles are not yet defined.

The proposed pipeline, although presenting a potential threat to archaeological sites, could facilitate the opportunity for their discovery. Archaeological field work would be scheduled as part of the construction sequence. The pipeline archaeology program should include field work both when the location survey is initiated and during grading and ditching operations. Key pipeline construction personnel would be instructed to recognize indicators of archaeological materials and would provide notice to the environment inspector.

VISUAL RESOURCES

Insufficient data are available to assess visual impacts.

LAND USE

Kitimat (population 13,000) is located 18 miles up-valley from the harbor, and is dependent on the pulp mill and the Alcan aluminum plant.

The pipeline route would follow existing transportation corridors, bypassing urban Kitimat and nearby agricultural land.

From Kitimat to Hinton (75 miles) the route is through forest land, largely following existing gas or crude oil pipeline corridors. The route would cross 90 miles of Mt Robson Provincial Park and Jasper National Park, both highly sensitive to impacts. The use of existing corridors will mitigate some impacts, but effects of construction would remain.

From Hinton to Edmonton the route follows the high northern Alberta plateaus, with forest lands extending almost to Edmonton before the transition to open prairie. Along most of this route segment the proposed pipeline would share the Trans Mountain crude oil pipeline right-of-way.

The pipeline right-of-way would contain a total of 5,565 acres. Approximately 3,858 acres are classed as potentially productive woodland sites. Another 127 acres are nonproductive woodland. About 793 acres are classified as open rangeland, improved pasture, or cropland. The remaining 787 acres are swamp, marsh, bog, or miscellaneous lands.

Land use on 5,565 acres would be affected. A permanent change in land use status would affect approximately 4,742 acres. About 3,858 acres of potentially productive woodland would be permanently lost for logging and wildlife. Within Mount Robson and Jasper Parks, 627 acres would have a permanent land use change.

Built-up areas would have changed land-use status because of limitations on activity within the pipeline corridor. Potential for residential, industrial, or commercial activity would be eliminated. Outdoor recreation would not be affected, other than by creating a potential for green belt areas. The route crosses mining and quarrying areas and would eliminate 20.1 acres for an future excavation.

TRANSPORTATION AND UTILITY NETWORKS

The proposed pipeline route would utilize the utility corridor concept to the extent feasible and economical. The route would remain close to or parallel existing highways, railways and utilities whenever possible. KPL would use the rights-of-way of British Columbia Hydro and Power Authority pipeline, Pacific Northern Gas pipeline, Provincial Highway 25 from Kitimat to Williams Creek, Provincial Highway 16 (Yellowhead Highway) from Telkwa to Edmonton, Trans Mountain Pipeline, and the Canadian National Railway. Untraversed land required would be minimal.

Increased truck traffic during construction would occur mainly on Provincial Highway 16 and could cause significant surface damage. The Canadian National Railway would probably experience an increase in freight hauling during construction. Operation of the pipeline would increase power demands on local transmission systems.

RECREATION

The proposed pipeline would create areas of conflict as well as greater opportunities for recreation in national, provincial, and community parks, park reserves, ecological reserves, natural areas, wilderness parks, historic sites, and campsites.

Impacts on aesthetics would occur when project personnel and large, heavy equipment were moved through recreational areas during construction. Visual impact, noise levels, and space taken up for construction and operation would be a source of irritation.

Clearing of a right-of-way through an ecological reserve would result in changes which would be detrimental to protected species.

Increased access to remote areas provided by the right-of-way would be both positive and negative. Previously remote park reserve areas would become accessible to cross-country skiers, hikers, and snow mobilers. But this accessibility could be construed as degrading the environment, and reducting wilderness qualities.

Oil spills could cause temporary impairment of the natural environmental or recreational potential, depending on the size and location of the leak and the success of cleanup operations.

Effects of construction within the parks could be minimized if construction occurred after Labor Day and before lasting snowfall. Conflicts between park visitors and pipeline construction would be reduced.

SOCIAL AND ECONOMIC CONDITIONS

Construction and operation of the proposed oil pipeline would result in direct and indirect social and economic impacts locally and regionally.

The route would be located near Highway 25 from Kitimat to Williams Creek, and near Highway 16 from Telkwa to Edmonton, passing through three incorporated communities (Kitimat, Prince George, and Edmonton) and close to many others. Facilities would include a dock at Kitimat with an access road paralleled by a 48-inch pipeline. Oil pumped through this line would be stored in an onshore storage facility in the industrial area of Kitimat, then transmitted to Edmonton via a 30- and 36-inch pipeline. There would be 10 pump stations, including one at Kitimat.

An undertermined number of pipeline maintainence centers could be required, each consisting of a prefabricated garage/warehouse. These would be located at pump stations or in towns near the route. Location of a control center has not been determined. The control center would be minor in terms of construction or permanent employment opportunities.

A labor force of 3,000 would be required at the peak of construction (see table 8.3.2-2). About 1,000 would be in the Kitimat-Terrace area and 2,000 along the rest of the route. About 650 jobs would be filled by local residents. The total project cost would exceed $500 million. At least 18 percent of this would be direct payroll to people working in the region and substantial amounts would be spent on local purchases of materials. Indirect employment generated within the region by material purchases and worker spending is unknown.

The total payroll for permanent employees following construction could amount to approximately $3 million per year, of which $500,000 would be paid in Kitimat.

Table 8.3.2-2 summarizes the dispersal of the construction labor forces, the peak number for each work force, and proposed accommodations. About 2,400 construction workers would be transient. About 850 would be located in the Kitimat-Terrace area. Most of these workers would come from elsewhere in British Columbia and Alberta. Few workers are expected to bring families because of the short construction period.

Accommodations and services for pipeline workers are not expected to pose serious problems over most of the pipeline route even though peak construction activity would occur during the tourist season in some areas. Considerable planning would be needed to accommodate the peak construction force in the Kitimat-Terrace area. Members of the pipeline spread who could not find accommodation in Terrace would live in a camp, probably near Williams Creek.

Minor adverse social and economic effects are expected during operation. Permanent employees would be few. Land for the storage facility and pump stations (except for that in Jasper Park) would be owned by KPL, and taxes would be paid on each site. Taxes paid to municipalities would be based on the length of pipe within each municipality.

TABLE 8.3.2-2 PROJECTED DISPERSAL OF CONSTRUCTION LABOR FORCE, APPROXIMATE SIZE AND POSSIBLE ACCOMMODATION, BY SPREAD

Activity	Peak Work Force	Housing
Dock installation at Kitimat	60	Kitimat
Storage facilities at Kitimat and pumphouse	200	Kitimat
Pipeline miles 0-65 and pump station	750	Terrace plus possible sleeper units south of Terrace
Pipeline miles 65-95	300	Camp near Kelkwa Pass at end of logging road from Smithers
Pipeline miles 95-215 and two pump stations	550	Base at Burns Lake, accommodation in towns along highway, plus sleepers if needed
Pipeline miles 215-355 and pump station	500	Base at Prince George, accommodation along highway, plus sleepers if required
Pipeline miles 355-550 and three pump stations	600	a) Camp north of McBride for Miles 355 - 463 b) Camp near Tete Jaune Cache plus available accommodation at Jasper
Pipeline miles 550-753	350	a) Edson area for Miles 550 - 565 and 611 - 671 b) Edmonton for Miles 671 - 753

Source: KPL 1979

Trans Mountain Oil Pipe Line Corporation

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8.4 TRANS MOUNTAIN OIL PIPE LINE CORPORATION

8.4.1 PROPOSAL

Trans Mountain Oil Pipe Line Corporation (TMC) and its Canadian affiliate, Trans Mountain Oil Pipe Line Company, Ltd. have proposed to construct a common carrier crude oil transporation system from Low Point, Washington, to Edmonton, Alberta, Canada. The system would transport Alaskan and foreign crude oil to existing pipelines connecting to refineries in the northern tier and interior states.

The system would consist of two single point moorings and unloading facilities with submarine pipeline delivery to onshore storage tanks at Low Point. A 30-inch pipe line would be constructed from Low Point to Edmonton where connections could be made to existing lines serving northern tier and inland states. The United States portion of the proposal is described in detail in chapter 1.

8.4.2 DESCRIPTION OF THE ENVIRONMENT

Environmental components are described in the detail considered necessary for identification and quantification of anticipated significant impacts. Environmental factors that would not be significantly affected are not described.

SEA LEG

The sea leg of the TMC proposal is similar to that for NTPC except for quantity, tanker mix, and destination. It includes areas that would be traversed by oil tankers from Alaska, Indonesia, and Iran prior to their arrival off Cape Flattery, Washington.

PORT AND ONSHORE FACILITIES

The approximately 42 nautical miles of sea lane through the Strait of Juan de Fuca from Cape Flattery to the moorage area at Low Point, the submarine pipelines, and the onshore storage facility are included in this section. Each environmental discipline is considered in relation to the proposal as described in chapter 1.

CLIMATE

Climate at Low Point is primarily influenced by the Pacific Ocean, the eastern Pacific high pressure zone in summer, and the Aleutian low in winter. Winters are mild, wet, and cloudy while summers tend to be cool and comparatively dry. Low Point and other portions of the Strait of Juan de Fuca are partially shielded from the Pacific storm systems by the Olympic Mountains and the coastal range on Vancouver Island. The basic climate of Low Point is similar to Port Angeles, (see chapter 2). However, it should be noted that precipitation, fog frequency, and wind direction may be different at Low Point due to local influences.

Wide variations exist in the average annual precipitation in the vicinity of Low Point. At Low Point average annual precipitation is about 50 inches. At Port

Angeles, it is about 25 inches, while at Clallam Bay, 20 miles to the west, the average is about 82 inches.

Temperatures in the Low Point area are moderated by the cool, moist, marine air from nearby coastal waters. Midwinter maximum temperatures tend to be in the mid 40s (°F) with minimums in the lower 30s (°F). Rare occurrences of very cold temperatures are associated with outbreaks of polar continental air from the interior. Midsummer temperatures also are moderate, with highs near 65°F and lows in the low 50s (°F). Temperatures rarely exceed 90°F. The average relative humidity based on data for Port Angeles is about 86 percent in the morning and about 77 percent in the afternoon.

Fog banks over the Pacific Ocean and the Strait of Juan de Fuca can restrict visibility, especially during late summer and early fall. At Port Angeles, heavy fog (restricting visibility to 1/4 mile or less) occurs 20 percent of the time in September. Visibility limited to 1 mile or less occurs 0.4 percent of the time in April and 12.5 percent of the time in October. Fog frequently increases as one goes westward along the Strait of Juan de Fuca (OIW 1977). Consequently, fog at Low Point would be expected more frequently than at Port Angeles.

The predominate wind direction observed at Port Angeles is west to west-northwest and is expected to be similar at Low Point. Winds are generally the strongest during summer when the eastern Pacific high has shifted northward (averaging 14 miles per hour in July). Lowest average wind speeds occur in the fall (7 miles per hour in October). Strong east winds occurring during winter are associated with the approach of migratory Pacific storm systems. Wind speeds greater than 26 miles per hour occur about 7 percent of the time; winds greater than 39 miles per hour occur less than 0.1 percent of the time.

High wind storms, thunderstorms, hailstorms, and tornadoes, are very rare. The highest 1-hour average wind speed recorded at Port Angeles was 58 miles per hour. The highest 1-hour rainfall observed was about 0.5 inches and the maximum recorded 24-hour rainfall was 3.3 inches. Record rainfall data for Low Point are not available, however, it is anticipated that they would be greater than Port Angeles.

Dispersion Potential

For a general definition of dispersion potential, see chapter 2.

No vertical temperature soundings exist for the Low Point area; however, limited soundings taken at Port Angeles show frequent temperature inversions in the summertime (EG&G 1973). Some inversions at Port Angeles exceed 1,000 meters and are attributable to the dominance of cool, marine air masses.

Vertical soundings are routinely taken at Seattle and Quillayute, on the northwest Washington coast. Data at Seattle indicate that inversions exist at ground level 52 percent of the time in the morning and 6 percent of the time in the afternoon. Elevated inversions also exist, particularly in summer, and are typically found between 1,000 to 1,500 meters above ground.

At Seattle average mixing heights are about 700 meters in the morning and about 1,000 meters in the afternoon (Holgrowth 1972). The Seattle station is subject to urban influences and is not affected to as great an extent as the Low Point area by maritime conditions. Expected mixing heights in the Low Point area are somewhat lower than Seattle, particularly in summer. This is supported by mixing heights observed at Quillayute, located on the Pacific Shore on the west side of the Olympic Peninsula. Mean maximum mixing heights there ranged from 472 meters in January to 1,079 meters in May (EG&G 1973).

According to atmospheric stability data, neutral conditions which indicate good mixing occur over the Port Angeles area about 63 percent of the time (SAI 1978). Unstable conditions, which represent more intense mixing occur about 15 percent of the time. Stable conditions the least favorable for dispersion, occur about 22 percent of the time. Wind speeds associated with stable conditions are usually very light. In the Low Point area stable conditions may occur when cool air flows in the Olympic Mountains or the ocean.

The above data indicate that dispersion conditions in the Low Point area are generally good. Best dispersion conditions would tend to occur in the winter and spring when storms are frequent. Worst conditions would tend to occur in summer and fall when more stable atmospheric conditions prevail.

AIR QUALITY

No air quality data exist for the Low Point area. Pollution levels are low, typical of rural areas. The nearest major pollution sources occur in Port Angeles, 18 miles to the east. These sources do not significantly affect air quality at Low Point. Concentrations of sulfur dioxide, particulates, nitrogen oxides, and carbon monoxide are expected to be low and well within ambient standards at Low Point.

The Low Point area would be subject to the same regulations and air quality standards as Port Angeles (see chapter 2). Low Point is subject to Class II incremental air quality standards. However, the Olympic National Park, whose northern boundary is about 5 miles south from the shoreline at Low Point is a Class I area, subject to more stringent pollution standards.

NOISE

Noise levels have not been measured at the Low Point site. Noise levels are expected to be low, typical of a rural, undeveloped area. Existing noise sources include traffic on Highway 112, rural home activities, recreational activity at the Lyre River Campground, and ocean surf along the Strait of Juan de Fuca. Sound dispersion is inhibited by the forest throughout the area. Noise sensitive receptors near the Low Point site include rural homes and campers at the Lyre River Campground.

TOPOGRAPHY AND GEOLOGY

Topography

The proposed port facility at Low Point is located on the northern coast of the Olympic Peninsula at the northern end of the Olympic Mountains. The proposed onshore storage facility would be located immediately west of Low Point on a nearly flat terrace that terminates abruptly against moderate to steep slopes (3 to 50 percent) adjacent to the coastline. The proposed 300-acre site lies about 125 to 175 feet above mean sea level.

Physical Geology

Quaternary (see table 2.1-10) glacial debris and other sediments form the surface of the proposed site. Late Pleistocene glacial till and outwash 11,000 to 15,000 years old cover the gentle upland slopes of the site and are from a few inches to more than 100 feet thick. Glacial and nonglacial deposits crop out beneath the surface along the steep coastline north of the site (Washington Department of Ecology 1978a). These deposits are underlain by southward dipping Miocene sedimentary rocks (Tabor and Cady 1978). The dominant bedrock structural feature in the vicinity is east-west trending syncline, the axis of which is just south of the site. Data concerning the geologic materials offshore from Low Point are discussed later in this chapter.

Geologic Hazards

Seismicity and slope instability are the only geologic processes considered capable of posing a serious threat to the Low Point area.

Seismicity. The proposed port and onshore storage facilities are in an area of moderate seismic activity classified as a seismic risk zone 2 (moderate earthquake damage expected; see glossary and Map Addendum). No earthquake epicenters have been identified within 10 miles of the site. Only five small earthquakes have been identified within 25 miles of the site (Puget Sound Power & Light Company (PSP&L) 1974; U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) 1975, 1976a). Larger earthquakes occasionally occur in the Puget Sound area and are felt at Low Point, but no damage has been reported. For locations of these larger earthquakes (see Map Addendum).

Geologic evidence indicates that the Port Angeles-Lake Crescent area has been structurally unstable since early Tertiary time, with faulting as recent as early Wisconsin time (55,000 to 8,000 years before the present (Brown et al. 1960). The nearest identified fault to the Low Point site is approximately 2 miles to the south-southwest (Tabor and Cady 1978). The age of faulting in the area has not been definitely determined, but recent faulting (within the last 10,000 years) is indicated only along the Calawah Fault located 10 miles south of the proposed site (Washington Public Power Supply System 1974).

Potential for liquefaction exists at the shore where water-saturated beach and offshore deposits cover dense material. These deposits consist of loose to medium dense sand and silt deposited by ocean currents. Seismically unstable materials have not been identified at the site.

Slope Instability. The coastline of the site has been identified as unstable (Washington Department of Ecology 1978a). The coastal bluffs consist of glacial drift and sediments that tend to be unstable at steep slopes. The nearest identified landslide is adjacent to the coast in Tertiary bedrock, one-half mile west of the proposed site (Washington Department of Ecology 1978).

Mineral Resources

Potential sand and gravel sources occur at the proposed facility, but are unutilized.

SOILS

A general discussion of soil classification and characteristics is provided in chapter 2.

Except for the steep slopes of the coastline, nearly all the soil at the proposed Low Point site is Agnew silty clay loam. This is a deep somewhat poorly drained glacial-outwash soil with nearly level surface. The soil generally has good fertility, and is classified as prime agricultural land. Perched water tables are common in this soil and might occur at the proposed site.

AQUATIC RESOURCES

Physical Components

Surface Water

The proposed site is located on an elevated tract of land between Murdock Creek (to the west) and the Lyre River (to the east). Murdock Creek has a drainage basin of about 4 square miles. The Lyre River and its tributaries drain an area of approximately 25 square miles. Susie Creek drains 4 square miles south and southeast of the site and flows into the Lyre River about one-third mile east of the site. No hydrologic records are available for these streams.

There are no records for domestic, agricultural, or municipal use of waters in the Low Point area.

Ground Water

The glacial and alluvial deposits at Low Point are possible sources of ground water. However, there are no wells or springs in the vicinity of the storage facility site. No ground water table or aquifers have been encountered by drilling activity in the area.

Biological Components

The Lyre River is used by salmon, coho, chinook, chum, and pink salmon, as well as searun and resident trout. Susie Creek is used for spawning and rearing by coho and chum salmon and searun and resident trout. Murdock Creek fishery resources have not been identified but probably include salmon and trout.

MARINE RESOURCES

Physical Components

Description

The discussion of the marine environment is limited to Grays Harbor to Cape Flattery, from Cape Flattery to Everett, and from the United States-Canadian border in the Strait of Georgia to Admiralty Inlet.

The distance between Grays Harbor and Cape Flattery is about 80 miles. The continental shelf varies in width and extends about 41 nautical miles off Cape Flattery. It is cut by numerous submarine canyons and the average depth is about 600 feet. The coastline is quite diverse with rocky bluffs and cliffs dominating the coast. Narrow beaches of sandy to cobble texture are irregularly interspersed.

The Strait of Juan de Fuca is about 90 nautical miles long with depths from 240 to 900 feet. Numerous shallower areas are concentrated near the eastern end. The width averages from 10 to 12 nautical miles between Cape Flattery and Low Point.

The eastern end of the Strait of Juan de Fuca leads into Admiralty Inlet, Haro Strait, and Rosario Strait. Admiralty Inlet is the main entrance to Puget Sound while Haro and Rosario Staits are formed by the San Juan Islands, and provide the entrance to the Strait of Georgia.

The Strait of Georgia is about 22 miles wide between Point Roberts and the north point of Galiano Island and extends southeasterly to Boundary Passage. Its width is about 19 miles between Lummi Bay and Saturna Island. The eastern edge is bordered by Washington state inner coastline; it is characterized by numerous banks and bays. The western border is bounded by the inner islands east of Vancouver Island and is characterized by bays, cliffs, and rocky shoreline. Water depths along the axis of the strait vary from 400 to 750 feet.

Oceanographic Conditions

The principal current which influences the entire northeast Pacific coast is the Subarctic Current (West Wind Drift Current) which diverges on the west coast of the North American continent. This divergence causes the formation of the north-setting Alaskan Current and the south-setting California Current. In the summer the divergence occurs at about 45°N latitude, as shown in figure 8.4.2-1. During summer, northwest winds blow parallel to the coast, causing surface water to move away from the coast. The result is an upwelling of cold, highly saline, nutrient-rich water. This divergence of surface water and the northwest winds may also enhance the south-setting California Current.

In winter the Subarctic Current diverges at about 40°N latitude. At this time the north-setting Davidson Countercurrent develops inshore of the Alaskan and California Currents, as shown in figure 8.4.2-1. It develops off the Washington coast in September and is well established by January. Towards spring it diminishes and by May disappears. A deep countercurrent flows north all year round.

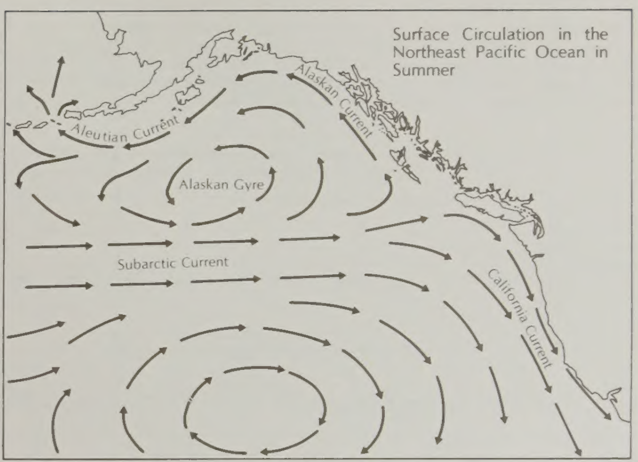


Figure 8.4.2-1

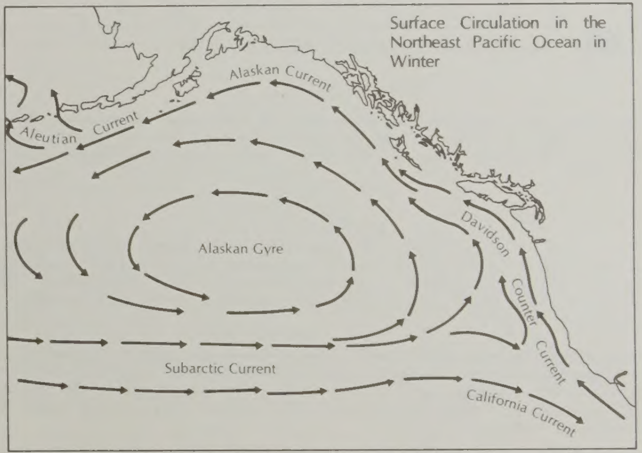


Figure 8.4.2-2

Wave directions off the Washington coast exhibit definite seasonal patterns in response to the wind direction. The predominant wave approach is from the northwest during the summer months and from the southwest in the winter months. Wave data during each month in northern Washington waters and at the entrance to the Strait of Juan de Fuca are given in table 8.4.2-1.

TABLE 8.4.2-1 WAVE DATA FOR THE WASHINGTON COAST
(Frequency of Occurrence, in Percent)

Deep Water Wave Height (Highest 1/3)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Northern Washington (35 nautical miles west of Kalalock)													
9'+	32.9	30.2	28.5	5.0	4.4	3.8	5.4	2.0	8.3	24.1	33.1	44.4	18.1
15'+	7.4	4.8	7.4	0.3	0.3	0.0	0.3	0.0	0.9	4.5	5.1	10.7	3.4
19'+	3.6	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.2	4.1	0.9
Entrance to Strait of Juan De Fuca													
9'+	7.6	11.7	8.1	1.4	2.7	2.3	4.5	0.3	4.8	11.7	20.9	15.9	7.4
15'+	1.6	1.5	1.7	0.0	0.0	0.0	0.3	0.0	0.0	2.2	3.9	2.3	1.0
19'+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.1	0.2

Source: Oceanographic Institute of Washington 1977

The wave data indicate that one-third of the waves approaching the northern Washington coast will be 15 feet or greater 10.7 percent of the time during December; whereas, at the entrance to the Strait such large waves occur only 2.3 percent of the time.

Strait of Juan de Fuca

The Strait of Juan de Fuca is generally quite deep, but there are shallow areas which tend to inhibit the flow of saltwater into the inland water system. These shallow areas are formed by glacial deposition and affect water characteristics, flushing times (that time required to replenish water in a system), and biological processes.

Generally, the movement of water within the system has three parts: a low salinity surface layer flowing seaward, a salty dense oceanic layer flowing landward near the bottom, and a mixture of the two which forms at the sills and contributes to both the surface and deepwater layers. The low salinity surface layer is a result of freshwater input.

Surface drift card studies in the Strait and Puget Sound confirmed the tendency for seaward flow of surface water. In addition, tidal currents provide the energy to mix the two waters and cause a surface flow oscillation with a net seaward movement at the surface.

The Strait is exposed to open ocean waves from a west-northwest direction. The majority of these waves are dispersed by shallow water as they enter the Strait. The result is a maximum wave height of about 15 feet within the inner Strait. Wave heights which might be encountered under various conditions in the Strait are displayed in table 8.4.2-2.

TABLE 8.4.2-2 THE HEIGHTS OF WAVES THEORETICALLY PRODUCED BY WINDS
OF VARIOUS STRENGTHS BLOWING OVER DIFFERENT DISTANCES

Wind Velocity (nautical miles per hour)	Distance (nautical miles) 10	50	100	300	500	1000
	Feet					
10	1.5	2.0	2.0	2.0	2.0	2.0
15	3.0	4.0	4.5	5.0	5.0	5.5
20	4.0	6.5	8.0	9.0	9.0	9.5
30	6.0	12.5	15.0	18.0	19.0	19.5
40	7.0	17.5	23.0	30.0	32.0	35.0
50	9.0	22.0	30.0	43.0	47.0	52.0

Source: Bigelow and Edmonson 1947

Tides at Low Point are of the mixed type, producing two unequal high and two unequal low tides during each complete tidal cycle (see table 8.4.2-3). Tidal currents at Low Point also have been estimated from available data (see table 8.4.2-4.

TABLE 8.4.2-3 TIDAL HEIGHTS FOR LOW POINT AND NEARBY AREAS

	Maximum High (feet)	Maximum Low (feet)	Mean Range (feet)	Diurnal Range (feet)
Twin River	9.0	-2.0	4.4	7.0
Low Point	8.3	-1.9	4.3	6.9
Crescent Bay	7.6	-1.8	4.1	6.7

Source: U.S. Department of Commerce 1978a for data on Twin Rivers and Crescent Bay

TABLE 8.4.2-4 MAXIMUM TIDAL CURRENTS FOR LOW POINT AND NEARBY AREAS

	Flood (knots)	Ebb (knots)
Pillar Point	1.4	0.9
Low Point	1.2	1.5
Angeles Point	1.0	2.2

Source: U.S. Department of Commerce 1978b for data on Pillar Point and Angeles Point

Waves within the Strait of Juan de Fuca are influenced by swells generated seaward of Cape Flattery and by local sea conditions. Refraction and shoaling also play an important role in modifying the incoming waves. Wave heights rarely exceed 10 feet inside the Strait.

The U.S. Army Corps of Engineers (1971) calculated wave heights for the Port Angeles area (table 8.4.2-5). Wave conditions are expected to be similar at Low Point.

TABLE 8.4.2-5 WAVE FORECASTS FOR LOCALLY GENERATED SEA WAVES AT EDIZ HOOK 1/

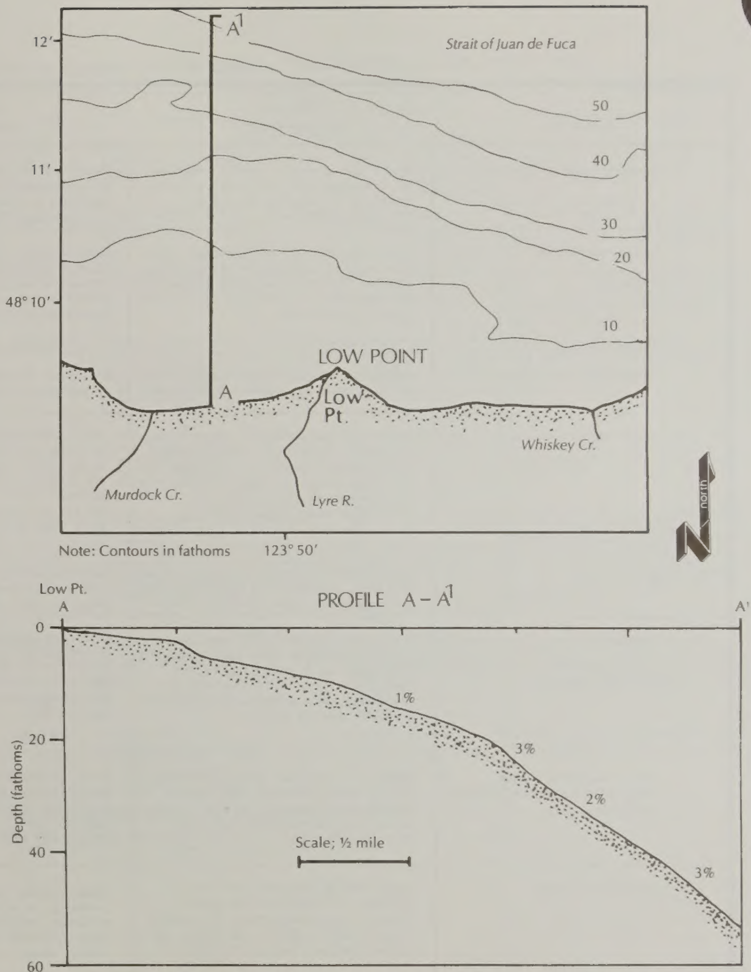
Direction of Approach	Annual Percentage of Occurrence (0.3-0.9m)	(0.9-1.5m)
West	28.0	2.0
Northwest	15.5	2.0
North	3.5	
Northeast	5.0	0.5
East	6.3	0.5

Source: U.S. Army Corps of Engineers 1971

1/ The wave height forecasts covered a 5-year period; the significant wave values are for deep water waves. The maximum forecast waves in these 5 years were significant waves of 8 feet from the northeast and 7.7 feet from the northwest.

The bathymetry at Low Point is characterized by a rather gently sloping near-shore region out to about 1.5 nautical miles with an average slope of 1 percent (see figure 8.4.2-3). Water depths in excess of 60 feet occur approximately 1.25 nautical miles due north of the onshore storage facilities. Beyond 1.5 nautical miles from shore, the bottom plunges more steeply toward the main channel where depths reach 600 feet. Bottom sediments consist of sand and gravel near shore and gravel, with outcrops of sedimentary bedrock, seaward.

The beach at Low Point is predominantly mixed cobble and sand. The direction of littoral transport probably varies in response to seasonal wind patterns. There are no obvious geomorphological features which indicate the net drift direction.



Note: Contours in fathoms

BATHYMETRY OFFSHORE OF LOW POINT

Figure 8.4.2-3

Source: NOAA 1978

TABLE 8.4.2-6 SUMMARY OF WASHINGTON STATE MARINE WATER QUALITY STANDARDS

Parameter	CLASS AA (Extraordinary)	CLASS A (Excellent)	CLASS B (Good)	CLASS C (Fair)
Fecal Coliform Organisms (organism/100 ml)	Shall not exceed a median value of 14 organisms/100 ml, with not more than 10% of samples exceeding 43 organism/100 m.	Shall not exceed a median value of 14 organisms/100 ml, with not more than 10% of samples exceeding 43 organisms/100 ml.	Shall not exceed a median value of 100 organisms/100 ml, with not more than 10% of samples exceeding 200 organisms/100 ml.	Shall not exceed a median value of 200 organisms/100 ml, with not more than 10% of samples exceeding 400 organisms/ 100 ml.
Dissolved Oxygen (mg/l)	Shall exceed 7.0 mg/l, except when the natural phenomenon of upwelling occurs, natural dissolved levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 6.0 mg/l, except when the natural phenomenon of upwelling occurs, natural dissolved levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 5.0 mg/l or 10% saturation, whichever is greater, except when the phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.	Shall exceed 4.0 mg/l or 50% saturation, whichever is greater, except when the natural phenomon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.
Total Dissolved Gases	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% of saturation at any point of sample collection.	Shall not exceed 110% saturation at any point of sample collection.
Temperature	Shall not exceed 13.0° Celsius due to human activities. When natural conditions exceed 13.0° Celsius, no temperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 16.0° Celsius due to human activities. When natural conditions exceed 16.0° Celsius, no termperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 19.0° Celsius due to human activities. When natural conditions exceed 19.C° Celsius, no temperature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.	Shall not exceed 22.0° Celsius due to human activities. When natural conditions exceed 22.0° Celsius, no temerature increase will be allowed which will raise the receiving water temperature by more than 0.3° Celsius.
pH	Shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.2 units.	Shall be within the range 7.0 to 8.5 with a man-caused variation within a range of less than 0.5 units.	Shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.5 units.	Shall be within the range of 6.5 to 9.0 with a man-caused variation within a range of less than 0.5 units.
Turbidity (Nephelometric Turbidity Units)	Shall not exceed 5 NTU over background turbidity when background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when background turbidity is more than 50 NTU.	Shall not exceed 5 NTU over background turbidity. When background, turbidity is 50 NTU or less, or have more than 10% increase when the background turbidity is more than 50 NTU.	Shall not exceed 10 NTU over background turbidity when background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more that 50 NTU.	Shall not exceed to 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic, Radioactive or Deleterious Material Concentrations	Shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any use.	Shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.	Shall be below those which adversely affect public health during characteristic uses, or which may cause acute or toxic conditions to the aquatic biota, or which may adversely affect characteristic water use.	Shall be below those which adversely affect public health during characteristic uses, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water use.
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.	Shall not be impaired by the presence of materials or their effects, excluding those of matural origin, which offend the senses of sight, smell, touch, or taste.	Shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.	Shall not be interfered with by the presence of obnoxious wastes, slimes, aquatic growth, or materials which will taint the flesh of edible species.

Adapted from Washington State Water Quality Standards 1977.

Marine Water Quality

The Washington State marine water quality standards contain four classifications, each based on characteristic uses to be protected (Washington Department of Ecology 1977a). The water quality criteria applicable to each classification are given in table 8.4.2-6. The entire Strait of Juan de Fuca is designated Class AA (Extraordinary).

In summer, the water column becomes temperature stratified and the dissolved oxygen content in bottom waters decreases. Salinity is reduced during the winter due to high river discharge. Density profiles show that ocean water moves eastward into and along the bottom of the Strait during the summer. This dense ocean water also will move into Puget Sound and displace bottom water in embayments which are hydrologically isolated by shallow sill areas.

Recent data for the eastern Strait of Juan de Fuca and northern Puget Sound region show typical concentrations of total suspended solids of 0.5 to 2 milligrams/liter (mg/l), with higher concentrations near river discharges (Baker et al. 1978). Hydrocarbon concentrations associated with the suspended matter range from 0.2 to 1.4 milligrams/gram dry weight of solids. These data indicate that although incipient levels may be present, suspended matter in this region is not obviously contaminated with petroleum hydrocarbons (Baker et al. 1978).

Only a limited amount of marine water quality data is available for Low Point. These data are listed in table 8.4.2-7 and indicate dissolved oxygen levels below the state Class AA criteria. Many chemical characteristics of the marine water at Low Point are similar to those found further offshore in the Strait of Juan de Fuca. Differences will occur because of local influences of bottom topography, beach processes, and river discharges.

TABLE 8.4.2-7 WATER QUALITY DATA FOR LOW POINT 1/

Parameter	Maximum	Minimum	Mean
Temperature, °C	10.26	6.92	8.46
Dissolved Oxygen, mg/l	7.82	3.34	5.51
Dissolved Oxygen, percent	85	34	58.25
Salinity, ppth	33.82	31.15	32.55

Source: EPA 1979
1/ 12 samples: taken June 4, 1963

Biological Components

Marine Biological Habitats

Washington State Department of Ecology (1975) has defined nine general habitat types by prominent physical and biological characteristics. rock, sand, mud, mixed-coarse, mixed-fine, kelp bed, eelgrass, salt marsh, and open water. A summary of the physical and biological characteristics of each type is given in table 8.4.2-8. The distribution is shown in the Map Addendum.

TABLE 8.4.2-8 CLASSIFICATION OF TIDAL HABITAT TYPES

Type	Substrata	Physical Characteristics			Biological Characteristics
		Wave and Current Action	Tidal Range	Slope	
Rock	Solid rock or very large, stable boulders	High to low	All	Any (if low, waves or currents usually high)	Productive. Diverse fauna at mid to lower intertidal; algae abundant. Important subtidal fish.
Sand	Approximately 4 to 0.25 mm( )	High to moderate	All	Shallow	Relatively unproductive, low diversity. Few algae. Some hardshell clams, crab nursery area (intertidal), adult crabs (subtidally).
Mud	Fine sand, silt, and clay (0.25mm)	Low	All	Shallow	Productive and diverse. Important oyster beds. Some clam production; some crab use. Often with eelgrass. Important subtidal fish; shorebird feeding; harbor seal haul out.
Mixed-coarse	Mostly cobble (256-64 mm), gravel (64-4mm), and sand with low mud or silt content. May have some scattered boulders (256 mm)	High to moderate	Intertidal to shallow subtidal	Medium	Relatively unproductive. May have hardshell clams, especially subtidally.
Mixed-fine	Mixed cobble, gravel sand, and shell fragments with high mud and silt content. May have scattered boulders.	Moderate to low.	All (usually below MSL)	Medium to shallow	Rich and diverse fauna. Important clam production; subtidal fish and crabs. Some eelgrass subtidally; algae attached to shell fragments and larger substrates.
Open water	Salt water medium which fluctuates in salinity, temperature	Variable	-	-	Wide variety of fish. Offshore feeding area for birds and marine mammals. Abundant phytoplankton and zooplankton.
Kelp bed	Mostly, brown kelp (Nereocystis leutkeana) attached to rock of cobble-size or greater.	Usually moderate but is variable	Depth from near MLLW to 50 feet below	Any	Good fish and invertebrate habitat. Several species of large brown algae and low-light tolerant red algae under Nereocystis canopy.
Eelgrass	Formed by dense beds of eelgrass (Zostera) on sand, muddy sand, or muds.	Moderate to low	Approximately from +3 feet to -12 feet relative to MSL	Mostly shallow. may be moderate along channels	Major food source for brant and many invertebrates. Crab and fish nursery. Herring spawning. Many algae species epiphtic on eelgrass. Effective trap for detritus.
Saltmarsh	Several species of gramminoid plants, forbs and herbs other than grasses on mud or mixed-fine with high organic content.	Low	Usually above	Shallow	Important breeding and feeding for waterfowl and nongame birds.

Source: Washington State Department of Ecology 1975.

MSL = mean sea level; MLLW = mean lower low water; MHW = mean high water. Grain sizes of 0.25 to 0.06 mm are often considered fine sand

TABLE 8.4.2-9 PREFERRED HABITAT TYPES FOR VARIOUS MARINE MAMMALS AND BIRDS

Organism	Status[1]	Utilization[2]	Open-water	Rock	Sand	Mud	Mixed coarse	Mixed fine	Eel-grass	Salt marsh	Kelp beds
Birds											
Black oyster-catchers		R		X			X				
Surfbirds		R		X			X				
Ruddy turnstones		R		X			X	X			
Black turnstones		R		X			X	X			
Wandering tattlers		R		X							
Spotted sandpipers		R		X		X		X			
Rock sandpipers		R		X	X		X	X			
Western sandpipers		R		X	X	X		X			
Great Blue Herons		R		X	X	X	X	X		X	
Plovers		R			X	X		X			
Yellowlegs		R			X	X		X		X	
Dunlins		R				X					
Dowitchers		R				X		X		X	
Whimbrels		R				X				X	
Killdeer		R				X	X				
Belted kingfisher		R				X	X	X			X
Cormorants		R	X	X			X				X
Common murres		R	X	X							
Marbled murrelets		R	X	X							
Rhinoceros auklets		R	X	X							
Pigeon guillemots		R	X	X							X
Gulls		R	X	X	X	X	X	X	X		X
Tufted puffins		R	X	X							
Terns		R	X		X						
Parasitic jaeger		R	X								X
Wilson's snipe		R								X	
Crows		R		X	X	X	X	X		X	
Ravens		R		X	X	X	X	X		X	
Bald eagles[3]	T[1]	R		X	X	X		X			
Ospreys		R				X					
Snowy owls		R								X	
Short-eared owls		R								X X	
Marsh hawks		R									
Gyrafalcons		R								X	
Peregrine falcons	E	R								X	
Merlins		R								X	
Violet-green swallows		R								X	
Savannah sparrows		R								X	
Harlequin ducks		S R	X	X							
Black brants		R	X		X		X	X	X		
Pintails		S R	X			X		X		X	
Green-winged teal		S R	X			X		X		X	
Mallards		S R	X					X		X	
Scoters		S R	X						X		X
Scaup		S R	X						X		
Loons		R	X						X		
Grebes		S R	X						X		
Coots		S R	X							X	
American widgeon		R	X						X	X	
Canvasbacks		S R								X	
Buffleheads		S R	X			X				X	
Canada geese		S R	X			X				X	
Mammals											
Seals		R	X	X	X	X	X	X	X	X	X
Sea lions		R		X			X				X
Whales	E	R	X								
Porpoises		R	X								
Otters		C[2]R		X	X		X	X	X	X	X
Raccoons[3]		SCR		X	X		X	X		X	
Stripped[3] skunks[3]		C R		X			X			X	
Opossums[3]				X						X	
Muskrats[3]		C R		X						X	
Minks[3]		C R								X	
Ermines[3]		C R								X	

Sources: Washington State Department of Ecology 1977; Federal Register 40(135), 3642-36431

Legend: Primary habitat available for bird usage. E = endangered species; T = threatened species; R = recreational value (bird watching); C = commercial value; S = sports value

1/ Threatened in Washington state and four other states. 2/River otters only. 3/Frequent visitor to marine habitats.

Preferred habitat for various bottom organisms, fish families, birds and mammals are given in tables 8.4.2-9 and 8.4.2-10 (Washington State Department of Ecology 1977).

Distribution of Marine Resources

The outer coast, Strait of Juan de Fuca, San Juan Islands, Strait of Georgia, and Puget Sound are rich in marine resources. These areas support abundant clams, shrimp, crab, fin fish, marine mammals, and diverse and abundant bird populations. Commercial and sport fisheries are found in all these locations. The general distribution of marine resources is shown in the Map Addendum.

Birds are abundant due to nesting, resting, feeding, and wintering habitat for plunge divers, divers, dabbling and diving ducks, geese, and shore birds. The Map Addendum shows the distribution of these bird groups.

TMC's proposal would most likely impact 15 marine areas. These areas are: outer coast--Cape Flattery to Grays Harbor, Neah Bay to Low Point, Low Point, Agate Bay to Port Angeles, Port Angeles, Green Point, Dungeness Spit and Bay, Sequim Bay, Discovery Bay, Protection Island and Dallas Bank, Admiralty Inlet, Whidbey Island (the west side), Smith and Minor Islands, Skagit Bay, and Saratoga Passage. Each is discussed in additional detail; the first seven are discussed below while the last eight are discussed under the pipeline section.

Some areas are referred to as critical or important habitat. The criteria for the two categories as designated by the Department of Ecology (November 1977) are:

1. Critical: the area supports a population of a species that not only consistently reproduces itself but because of favorable environmental conditions provides the major source of recruitment for adjacent areas whose populations do not consistently reproduce themselves.

2. Important: the area consists of a habitat type or types that provide shelter, food, or other environmental necessities during a critical part of a species life history.

Outer Coast--Cape Flattery to Grays Harbor

Marine life in this region supports a variety of commercial fisheries. Cape Flattery to Destruction Island is an important trawl ground for ocean perch, rockfish, lingcod, sable fish, Pacific cod, Dover and English sole, and starry flounder. Petrale sole are trawled from Destruction Island south past Grays Harbor to the Columbia River, while ocean pink shrimp are trawled from Cape Johnson to Willapa Bay. Particularly important shrimping areas occur within and offshore Grays Harbor. Salmon trolling occurs throughout this area and other important commercial species include Pacific herring, anchovy, and tuna.

The coast between Cape Flattery and Grays Harbor comprises the Washington Islands wilderness area and includes three National Wildlife Refuges (NWR): Flattery Rocks NWR, Quillayute NWR, and Copalis NWR. Hundreds of offshore rocks, islets, and islands provide habitat for many species of birds and marine mammals. South of Point Greenville in the Copalis NWR the character of the coast becomes sandy and important sand-marsh-mud habitats are found in river mouths and Grays Harbor.

TABLE 8.4.2-10 PREFERRED HABITAT TYPES FOR VARIOUS MARINE ORGANISMS

Organisms	Utili-zation	Habitat								
		Open* Water	Rock	Sand	Mud	Mixed Coarse	Mixed Fine	Eel Grass	Kelp Beds	Salt Marsh
Benthic Phyla										
Echinoderms (starfish, urchins,etc.)	C,S	X	X	X	X	X	X	X	X	
Crustaceans (crabs,shrimp, etc.)	C,S	X	X	X	X	X	X	X	X	X
Annelids (worms)	S	X	X	X	X	X				
Molluscs (oysters, clams,etc,)	C,S	X	X	X	X	X	X	X		
Fish Families										
Sable fish	C,S	X		X				X	X	
Greenlings	C,S	X	X		X	X	X	X	X	
Flounder	C,S	X		X	X	X	X	X		
Toadfish		X		X	X	X	X	X		
Codfish	C,S	X	X	X		X	X	X		
Wolffish	S	X	X			X				
Scorpion fish (rock fish)	C,S	X				X	X	X	X	
Sturgeon	S	A		X	X					
Sculpins	S	X	X	X	X	X	X		X	
Surfperch	C,S	X	X	X	X	X	X	X	X	
Gunnels		X	X	X	X	X	X	X	X	
Herring	C,S	X	X	X	X	X	X	X	X	
Anchovie	C,S	X	X	X	X	X		X		
Salmonids	C,S	A		X		X	X			
Smelt	C,S	A,X		X		X	X			
Drum	S	X							X	
Sandlance		X	X	X	X	X	X			
Sharks	C,S	X	X	X	X	X	X		X	
Skates	C,S	X	X	X						
Chimaeras		X	X	X		X	X			
Plankters										
Phytoplankton		X								
Permanent zooplankton		X								
Temporary zooplankton (fish and benthic larvae)		X								

Source: Washington State Department of Ecology 1977.

*Where open water is checked for organisms, the associated bottom habitat types for those organisms are also checked. The habitat types checked are for any life stage (larval or adult). This chart does not imply that organisms do not range into other habitats.

Legend: X = organisms found in this habitat during some or all life stages;
A = anadromous fishes; C = commercial fishing; S = sports fishing.

The Department of Ecology (November 1977) lists many critical habitats within this section of coast.

Species with critical habitat in the area include: Brandt's cormorant, pelagic cormorant, glaucous winged gull, Thayer's gull, common murre, pigeon guillemot, tufted puffin, black oyster catcher, Steller sea lion, harbor seal, sea otter, river otter, northern bald eagle, western grebe, double crested cormorant, white winged scoter, surf scoter, and Cassin's auklet.

Grays Harbor includes a large area of biologically rich tideflats and marsh. The bay helps support an ocean pink shrimp fishery. Also Dungeness crabs are abundant and large portions of Grays Harbor are classified as critical habitat. Fishes with critical habitat are the English sole, starry flounder, green sturgeon, white sturgeon, and American shad. Black brandt, mallard, pintail, American wigeon, canvasback, glaucous winged gull, western gull, common murre, rhinoceros auklet, and northern bald eagle are listed as having critical habitat here.

For a detailed discussion of this area refer to "A Summary of Knowledge of the Oregon and Washington Coastal Zone and Offshore Areas" (OIW 1977) and "Washington Coastal Areas of Major Biological Significance" (Washington Department of Ecology 1977).

Neah Bay to Low Point

Neah Bay is a small bay just east of Cape Flattery. Extraordinary water quality and a variety of habitats, including rock, gravel, and sand contribute to its quality. Intertidal clams, bottom fish, and salmon are abundant. The Washington Department of Ecology (1977) listed Waadah Island as a critical haul-out area for harbor seals. The area from Neah Bay west to Cape Flattery is identified as a major waterfowl area (Washington Department of Natural Resources 1974). The Pysht River estuary is a large estuarine system with extensive marsh, sand spits, sand flats, and a small lagoon. It is largely undisturbed and highly productive. Clams, crabs, and waterfowl are abundant. The area is an important nursery for many marine species. Also, steelhead, cutthroat, and salmon run in the river.

Low Point

Low Point appears to have relatively less biological significance than any of the 13 areas. It has been designated a critical habitat for harbor seals, who utilize Low Point year around (Department of Ecology 1977). No large concentrations of birds are found here (Washington Department of Fish and Game 1975). American wigeons, probably the most common duck in the Straits and Sound, frequent Low Point between October and April. Pigeon guillemots occur offshore at Low Point and common goldeneyes and buffleheads are found just to the east. Kelp beds occur offshore and abundant salmon, rockfish, ling cod, greenling, and halibut support recreational fisheries just to the east and west of Low Point. These are probably abundant at Low Point as well, but are not sought because of relative inaccessability. No clam beds or crab or shrimp resources are reported for this area.

Agate Bay to Port Angeles

Agate Bay and Crescent Bay (directly to the east) are critical habitat for the Pacific halibut. Eastern part of Crescent Bay and round Tongue Point has been designated critical habitat for river otters. The Department of Ecology (1977) lists the greater scaup, black oyster catcher, spotted sandpiper, and dunlin as the four most common birds in Crescent Bay. The area between Tongue and Observatory Points is designated as critical habitat for northern bald eagle. This Tongue-Observatory Point area supports a major kelp bed.

The Elwha River estuary provides salt marsh habitat, sand flats, and shallow channels for many invertebrates, fishes, and birds. Crabs are abundant off the river mouth.

Port Angeles

The western portion of Port Angeles and the area north of Ediz Hook have been designated critical habitat for Pacific halibut during the spring and summer. Surf smelt spawn in the bay. The area is an important resting and feeding area for birds (Department of Ecology 1977). Subtidal and intertidal clams are abundant throughout the harbor. The southeastern portion of the harbor is noted as a major clam bed estimated at 100 acres. Harbor seals are also common here as well as river otters. The Department of Ecology (1977) lists the primary habitats here as sand, mud, mixed-fine and open water. Large eel grass beds and kelp beds are also present slightly to the east, near Morse Creek.

Green Point

Of 47 major hard shell clam beds listed by Goodwin and Shaul (1978) Green Point is second in area and third in estimated pounds of butter, littleneck, and horse clams. Goodwin (1978) lists 51 geoduck clam beds, two of which are off Green Point and rank first and third. Together they account for 16 percent of the total estimated population of geoduck clams. The Department of Ecology (November 1977) listed the area off Green Point as critical habitat for Pacific Halibut. Terrestrial portions of Green Point are utilized by the endangered bald eagle.

Dungeness Spit and Bay

Like Cape Flattery, Dungeness Spit and Bay is a National Wildlife Refuge. The Department of Ecology (November 1977) has listed this area as a critical habitat for surf smelt, Pacific halibut, river otter, harbor seal, black brandt, mallard, pintail, American wigeon, and canvas back.

The Department of Ecology (November 1977) has classified the area from Dungeness to Sequim Bay as important for western grebe, western Canada goose, white fronted goose, Barrow's goldeneye, buffle head, old squaw, white winged scoter, surf scoter, greater scaup, rhinoceros auklet, least sand piper, dunlin, western sandpiper, sanderling, semi-palmated plover, and killdeer. Dungeness Spit and Bay have been given the highest possible rating (XXXX) on a statewide basis (Department of Ecology November 1977).

Goodwin and Shaul (1978) rank Dungeness Spit as the most important major hard shell clam bed in Puget Sound, based on estimated total clam weight, and third based upon area. Goodwin (1978) ranks Dungeness second out of 51 major geoduck beds based upon both the total population estimate and size of the bed. Crabs and Pacific oysters (culture) also occur here as well as large numbers of octopus which supports a commercial fishery. In addition, Dungeness Spit and Bay provide extensive sand-mud flats, a large marsh and lagoon, and eel grass and kelp beds.

Marine Mammals

Several marine mammals occur in the Strait of Juan de Fuca, Strait of Georgia and Puget Sound. For a detailed discussion see National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum Environmental Research Laboratories (ERL) MESA "Marine Mammals of Northern Puget Sound and the Strait of Juan de Fuca," January 1979, and the Washington Department of Ecology's "Washington Coastal Areas of Major Biological Significance," November 1977. There are 5 species of seals and sea lions, 15 species of whales and porpoises, and 2 species of otters. The four most abundant year-round residents are harbor seals, harbor porpoise, killer whales, and river otters. The distribution of these and other major marine mammals is shown on the Map Addendum.

The five species of seals and sea lions in this area are: California sea lion, Steller's sea lion (also called northern sea lion), northern fur seal, harbor seal, and northern elephant seal. Only the harbor seal is year-round resident. Population estimates range from 1,600 (NOAA Technical Mem., January 1979) to 5,460 (Department of Ecology November 1977). Harbor seals are common throughout both Straits and the Sound. California and northern sea lions utilize Tatoosh Island/Cape Flattery, Sombrio Point and Race Rocks (Vancouver Island), and Lucia Island (San Juan Islands; California and Steller sea lions are common at these sites during the winter. Occasional sightings occur throughout the entire area. Elephant seals have been sighted in the Strait of Juan de Fuca, the San Juan Islands and south of Seattle in Puget Sound. They are not abundant. Fur seals, once common in Washington waters, are only sighted occasionally in the Strait of Juan de Fuca and Puget Sound.

Fifteen species of whales and porpoises are listed by the NOAA Technical Memorandum (January 1979) as occurring in Puget Sound and the Strait of Juan de Fuca. Killer whales, harbor porpoise, minke whale and Dall porpoise are abundant. Populations of the first two species are fairly constant year round. The Dall porpoise are present primarily during the spring and summer. Minke whales are sighted year round, but their utilization of the area is concentrated in the spring and summer. Distribution is illustrated on the Map Addendum. All of the remaining 11 species are uncommon. Six have only been recorded on two, or fewer occasions. These are the white head grampus, false killer whale, pygmy sperm whale, North Pacific giant bottlenose whale, goose beak whale, and the saddle back dolphin. The Pacific white-side dolphin is abundant on the outer coast and outer straits, but rare in the inner Straits and Sound. Only seven have been sighted in Admiralty Inlet. Four shortfin pilot whales have been reported off the outer coast and one on Hood Canal.

Gray, fin, and humpback whales are listed as endangered species. The gray whale population is in a less precarious status than the fin or hump back populations. The NOAA Tech. Mem. (January 1979) reports 59 sightings as far south as Olympia of 75 gray whales within the Strait and Sound, between March 1976 and July 1978. Fin whales were once an important species and are now sighted occasionally in the Strait of Georgia. Within Washington waters, they would be likely to be seen in the outer reaches of the Strait of Juan de Fuca. Humpbacks were the most common large whale in this area during the first half of this century. Two sightings have occurred in recent years: May 1976 and September 1978. Any gray, fin, or humpback whale in inland waters should be considered strays.

River otter and the sea otter occur here. River otters are particularly abundant in the San Juan Islands, Saratoga Passage, Dungeness Bay and Port Angeles.

Sea otters were once abundant along the outer coast, but were hunted to near extinction and eliminated from Washington waters around 1910. Fifty sea otters were released along the coast north of Grays Harbor in 1969 and 1970; the population remains small. Conflicting reports indicate there are only about 22 animals in Washington waters. Occasionally, a stray probably wanders into the Strait or Sound.

Threatened and Endangered Species

Gray, fin, and hump back whales have been discussed in the preceding section.

TERRESTRIAL VEGETATION

The proposed onshore storage site at Low Point lies within a broad vegetative zone defined by Franklin and Dyrness (1973) as the Sitka spruce zone. Major tree species include Sitka spruce, western hemlock, western red cedar, Douglas-fir, and grand fir. Lodgepole pine is often found along the ocean, while red alder generally occupies previously disturbed sites.

Mature forests have lush understories of herbs shrubs, ferns, and mosses, that is often too dense to walk through easily (Franklin and Dyrness 1973). Within a 1-mile semi-circle from the proposed site, 58 percent of the area is occupied by an immature mixed forest, 25 percent is covered by a young forest of red alder, 9 percent is forest that has been disturbed but has not yet been replaced by tree species, 7 percent is occupied by crop or pastureland, and 1 percent is beach shoreline (NTPC 1978). The distribution of these vegetative associations and land use types are shown in figure 8.4.2-4.

TERRESTRIAL WILDLIFE

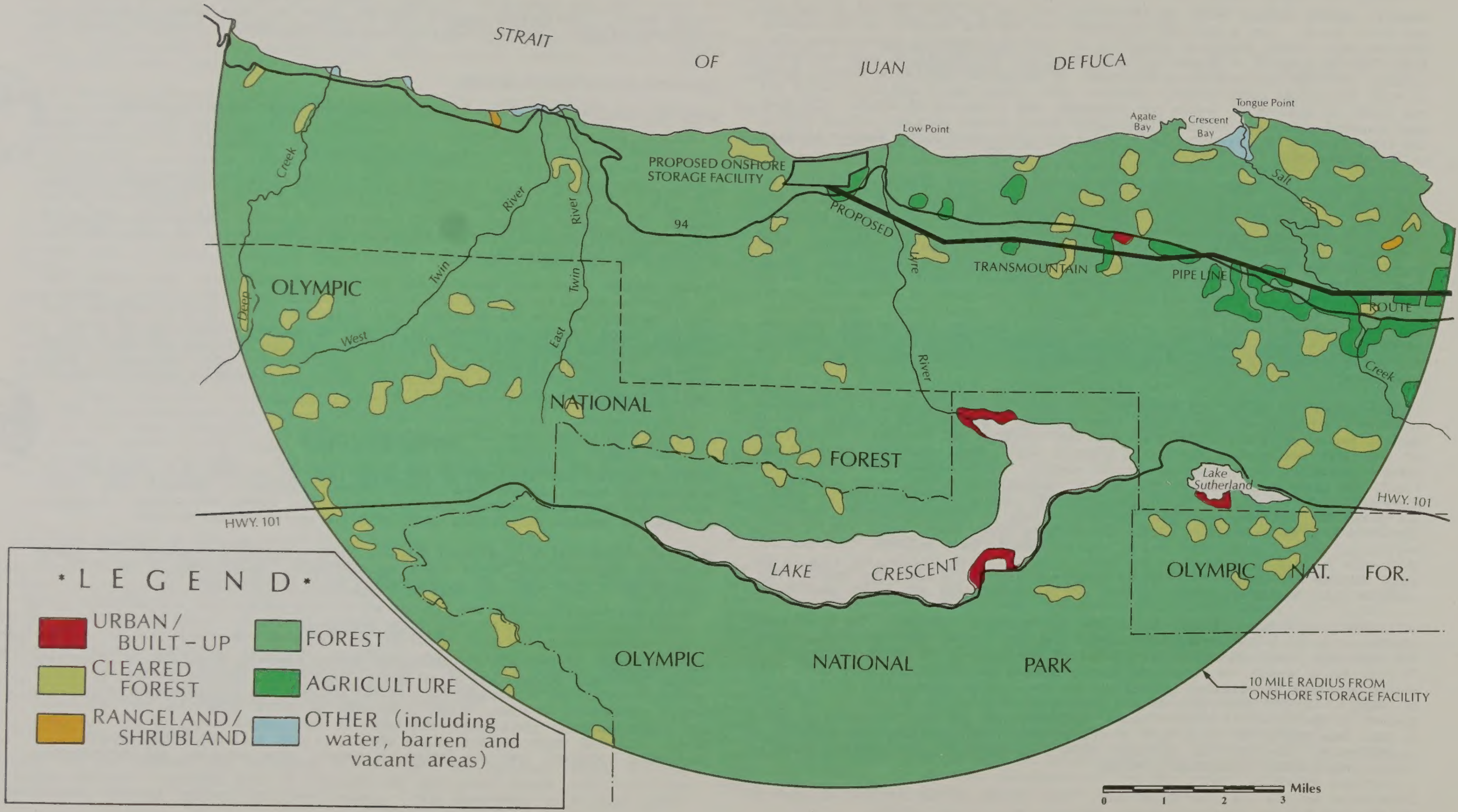
Wildlife species characteristic of the region include big game (i.e. black bear and black-tailed deer), upland game (i.e., eastern cottontail, snowshoe hare, ruffed grouse, and band-tailed pigeon) and furbearers (i.e., beaver and racoon). A variety of waterfowl inhabit the vicinity (NTPC 1978) and were discussed earlier.

No rare, endangered, or threatened wildlife species are known to occur at Low Point. There are northern bald eagle nests approximately 2 miles west of the site, at Crescent Bay 5 miles east, and at Observatory Point 10 miles east.

CULTURAL RESOURCES

Cultural resources include archaeological sites; historic structures or properties valued for their designation of an event, significant historic period, or architecture; objects and structures that reflect achievements in engineering or artistic design (monuments, bridges, ships, railroads, or other industrial constructions); and paleontological sites that contribute to our understanding of past environments. Cultural resources are unique records of past activities that occurred at a particular location, and are finite in number, irreplaceable, and nonrenewable.

Land Use of Low Point Area



Archaelogocial and Historical Resources

Two documented prehistoric sites are located on the site of the proposed onshore storage facility at Low Point. The gently sloping beach with Murdock Creek and the Lyre River provided a good settlement and fishing area.

The latest edition of the National Register of Historic Places (February 6, 1979) does not list any sites at Low Point. However, the majority of the southern coastline of the Strait of Juan de Fuca is recognized as traditional Clallam Indian territory (NTPC 1978) with a potential for archaeological and historical sites.

No available documents suggest the presence of underwater archaeological sites in the vicinity of Low Point.

Paleontological Resources

No fossil sites are known to exist at Low Point. There is a marine fossil site near West Twin River about 10 miles west of Low Point along the bluffs that border the Strait of Juan de Fuca. At this location, fossilized clams, oysters, snails, and limpets are found (Livingston 1959).

VISUAL RESOURCES

Visually Low Point is somewhat level, partially wooded, and generally undeveloped. The surrounding area is a forested coastal plain, bounded by shoreline bluffs to the north. Two residences are located in the immediate foreground zone east of the site along the Lyre River. Views of Low Point from these homes are dominated by forest vegetation. Ten residences are located along State Highway 112, which ranges from 200 to 800 feet from the southern boundary of the site. The site would be within the foreground views from these locations.

Lyre Creek Campground, located along the shoreline just east of the site, has unobstructed views of the northern portions of the site. However, the view is generally directed northward to the Strait of Juan de Fuca. Beyond this vicinity, views of the site are generally limited to points offshore and to remote woodland areas at higher elevations. The scenic quality of this forested area is rated Class II, A/B (USFS-Retention).

LAND USE

Existing Land Use

The proposed 300-acre site at Low Point is forested with intermittent pastureland at the southeast corner of the site and a small amount of residential development (see table 8.4.2-11). There are three residential structures on the site, a few located to the east, and 10 single-family dwellings situated along Highway 112 to the south of the site. As indicated in figure 8.4.2-5, the lands within 10 miles of the site are similar in character--predominately woodland/forest with intermittent pastureland and scattered rural residential development.

Land Use of Port Angeles Area

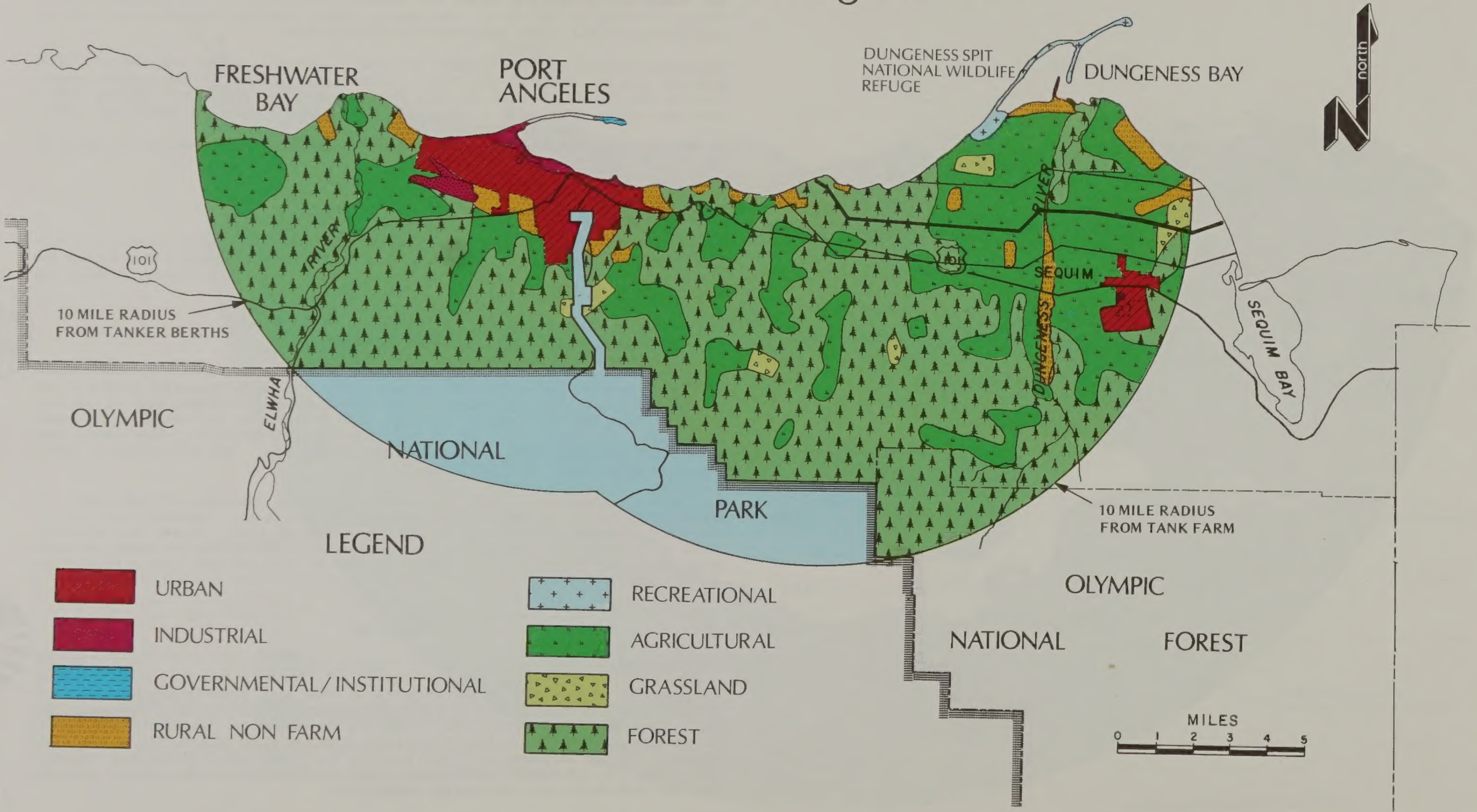


TABLE 8.4.2-11 CLALLAM COUNTY LAND USE (1971)

Use	Acres	Percent
Residential	13,660	1
Industrial	650	.06
Commercial	157	.00
Agricultural1/	64,092	6
Timber2/	999,898	89

Source: Clallam County Preliminary Comprehensive Plan 1977

1/ Includes small private forests.

2/ Includes federal, state, and private.

Land Use Plans and Zoning

No zoning ordinances currently exist for Low Point and the surrounding area. The Low Point site is within the 55,392-acre portion of the "potential living area" of the county that is undesignated (Clallam County Comprehensive Plan 1967). Lands within 10 miles of Low Point are undesignated, designated as "potential living areas," or part of the Olympic National Park.

Special Management Areas

The northern portion of the proposed onshore storage facility site is beach and adjacent land along the Strait of Juan de Fuca designated a "conservancy environment" in the Clallam County Shoreline Master Program (Clallam County Shoreline Advisory Committee 1976). A "conservancy environment" is a shoreline area designated for protection, conservation, and management of existing natural resources and historic and cultural areas. Such areas are characterized by low-intensity land use and moderate-intensity water use, with moderate to low numbers of permanent structures and occupancy.

Clallam County Land Ownership

Approximately 48 percent of all land in Clallam County is federally owned; state-owned lands represent about 6 percent of the county. Private and local ownership accounts for the remaining 46 percent. The Clallam County Governmental Conference "Housing Inventory and Impact Baseline Data" excludes land owned by private timber concerns and concludes that 11 percent (130,000 acres), is available for development (CCGC 1977).

Existing Land Use

Existing land use in Clallam County is displayed in table 8.4.2-11. Figure 8.4.2-5 shows land use within a 10-mile radius of the proposed onshore storage facility at Low Point. Agricultural land in the county is gradually being converted to residential use. Within the county, total acreage in farms declined 11 percent between 1969 and 1974.

Special Management Areas

Land with special mangagement concerns within Clallam County include Native American areas, the Dungeness National Wildlife Preserve, and the Olympic National Park.

The proposed port and onshore storage facilities are located about 5 miles north of Olympic National Park. Except for small areas near the periphery being managed for general recreation, the 908,692-acre park is proposed for wilderness designation. The Dungeness National Wildlife Refuge is about 35 miles east of Low Point.

The Washington Environmental Atlas (U.S. Army Corps of Engineers 1975) indicates that there is a proposed research and educational area at Slip Point near Clallam Bay, about 20 miles west of Low Point.

The Pacific Rim and proposed West Coast National Parks are across the Strait of Juan de Fuca in along the west coast of Vancouver Island, Canada.

Land Use Plans and Zoning

The Clallam County Comprehensive Plan designates all land within the county except federal, state, and timber company owned land (100,440 acres, or 9 percent of the land within Clallam County) as potential living area. Of the potential living area, 348 acres (less than 0.5 percent) is designated for industrial use (Clallam County 1967).

A new comprehensive plan for Clallam County is expected to be adopted in late 1979. The draft document, "Clallam County Comprehensive Land Use Plan," (Clallum County Planning Department 1977), indicates that the planned use of Low Point is the same as the one designated within the 1967 comprehensive plan.

In 1976, Clallam County adopted an ordinance which states:

> With the discovery and development of the Alaskan oil fields ... there is a possibility that a port in Clallam County would be proposed as a major oil transfer facility. ... The county through this comprehensive plan declares such an oil port and related facilities are incompatible with existing uses and prohibits their location in all areas under the jurisdiction of the plan. (Ordinance No. 70 of 1976).

This ordinance is currently in effect and will be incorporated into the proposed comprehensive plan (Clallam County Planning Department 1979).

TRANSPORTATION AND UTILITY NETWORKS

Inland Waterways

Vessel traffic between the Pacific Ocean and Puget Sound passes through the Strait and is shown in table 8.4.2-12. The area in the Strait of Juan de Fuca between the vessel traffic lane and the shoreline is used for naval maneuvers and sport and commercial fishing.

TABLE 8.4.2-12 VESSEL TRAFFIC ON THE STRAIT OF JUAN DE FUCA IN 1977 1/

Month	Vessel Type						Total
	Freighter	Tanker	Tug	Government	Ferry	Misc.	
January	580	93	308	101	18	13	1,113
February	546	83	236	107	53	10	1,035
March	570	94	293	130	108	9	1,204
April	632	112	293	91	135	3	1,266
May	631	94	224	121	164	10	1,244
June	564	99	240	216	274	16	1,409
July	622	108	229	138	318	11	1,426
August	634	103	202	131	322	20	1,412
September	586	96	223	100	292	21	1,318
October	644	116	239	96	163	11	1,269
November	584	100	376	67	120	17	1,264
December	605	106	318	87	124	16	1,256
Total	7,198	1,204	3,181	1,385	2,091	157	15,246

Source: NTPC 1978

1/ The data reflect the number of vessel movements, not the number of vessels. For example, if a vessel stops at one port, it makes two reported movements; if it stops at two ports, it makes three reported movements.

Roads and Highway Networks

U.S. Highway 101 and Washington State Route 112 are the primary east-west roads in Clallam County. The average daily traffic in 1976 for U.S. Highway 101 in the vicinity of Port Angeles was 17,400 vehicles; however, traffic increases dramatically during summer weekends from tourist activities. Washington State Route 112, which passes within 200 to 800 feet to the south of the site boundary at Low Point, provides the primary access between Port Angeles and Neah Bay. Average daily traffic on Highway 112 is approximately 2,000 vehicles. The Low Point site is accessible from Highway 112 and local roads.

Railroads

Clallam County is served by the Milwaukee Railroad, which enters the county from the east and terminates at Port Angeles (about 18 miles east of Low Point). Currently, there is no rail service to Low Point.

Air Transport

The Clallam County Airport (William R. Fairchild International) at Port Angeles is the closest public airport to Low Point. It is a commuter service/general utility airport which is regularly served by one or more carriers not certified by the Civil Aeronautics Board. Landings and takeoffs for 1976 were 72,000, about one-third the estimated capacity.

Electric Transmission

The principal source of electric power for Clallam County is the Bonneville Power ville Power Administration (BPA). BPA service is via a 230-kV and 115-kV transmission lines.

Power supply is a complex issue in the region. In 1976, BPA advised its public utility customers, its firm energy resources would be insufficient to meet firm energy requirements beginning in 1983. After that date, power supplied to BPA's preference customers, which includes the Port Angeles and Clallam county utilities, will be based on an allocation system stated in existing contracts.

BPA is currently developing a new allocation formula to be used in new power sales contracts. As a result, Port Angles and Clallam County utilities have contracted for power from the Washington Public Power Supply System (WPPSS), Thermal Units 4 and 5. Construction of these units has been delayed and power will not be available from them until 1985 or 1986, if then. In future contracts with BPA, public utilities must be aware that BPA might receive new applications for power from entities that would have a statutory preference on federal power. Future power supply might also be affected by regional power legislation presently being considered by Congress. Current forecasts of electrical power availability indicate there might be shortages in regional power availability, based on critical water year conditions, in any year from the present through the 1980s. (A critical water year is considered to occur 1 year in 10.)

Trends in Clallam County Public Utility District's (PUD) load growth are shown in table 8.4.2-13. Peak load in 1977 was more than ten times greater than peak load in 1955, consistent with the more than tenfold increase in energy sales during this period. The average load has grown almost proportionally to peak load, as indicated by the very similar load factors in 1955 and 1977; the load factor has varied only 7.4 percent for the data points shown in table 8.4.2-13. This relatively constant load factor is largely explained by the large share of power used by residential customers.

TABLE 8.4.2-13 NUMBER OF CUSTOMERS SERVED BY THE CLALLAM COUNTY PUD BY CATEGORY FOR SELECTED YEARS, 1955 to 1975

Category	Number of Customers			
	1955	1965	1970	1975
Residential	3,869	5,344	7,186	10,696
Commercial	518	813	1,050	1,433
Industrial	--	13	17	25
Irrigation	143	183	--	206
Other	16	74	56	4
Total	4,546	6,427	8,309	12,364

Source: NTPC 1978

TABLE 8.4.2-14 PEAK LOAD, AVERAGE LOAD, AND LOAD FACTOR OF THE CLALLAM COUNTY PUD FOR SELECTED YEARS, 1955 TO 1977

Year	Peak Load (Mw)	Average Load (Mw) 1/	Load Factor (percent) 2/
1955	9.1	3.7	40.7
1965	27.8	11.8	42.4
1970	45.4	19.7	43.4
1975	83.6	38.7	46.3
1976	86.2	41.5	48.1
1977	105.7	44.2	42.1

Source: NTPC 1978

1/ Average load for 1955, 1965, and 1970 calculated from energy sales data.

2/ Load factor = $\frac{\text{average load}}{\text{peak load}}$

RECREATION

This section addresses marine and non-marine related recreation. Oil spill risk studies have determined that portions of the Pacific coastline, Strait of Juan de Fuca, and Puget Sound may be impacted by a marine oil spill; for this reason these areas are included with the discussion of the port and onshore storage facilities. Shoreline parks and fishing areas are shown in the Map Addendum.

Marine Related Recreation

The majority of sports fishing in the Strait of Juan de Fuca is for salmon with lesser effort for ling cod, rockfish, and greenling. Major salmon fishing areas along the Strait are Sekiu to Pillar Point, Crescent and Freshwater Bays, Ediz Hook, Dungeness Spit, and Port Discovery. Approximately eight percent of marine sports salmon fishing in Washington occurs in the Strait of Juan de Fuca.

The majority of sport salmon fishing (63 percent), however, occurs off the Pacific coast between Grays Harbor and Cape Flattery. Approximately 1.2 million marine angler trips occurred along this segment in 1977 (Washington Department of Fisheries, Pers. Comm. 1979). Puget Sound, particularly the San Juan Islands along the northwest portion of Whidbey Island, and off Port Townsend, Admiralty Inlet, Holmes Harbor, and Saratoga Passage are other areas for salmon fishing.

Areas in the central Puget Sound and the San Juan Islands account for more than 70 percent of the total bottomfish catch. Other areas near Neah Bay and from Pillar Point to Low Point also supply bottomfish.

Shellfish gathering is an important recreational activity along the Strait, Pacific coastline, Sound, and Hood Canal where access to tidelands is permitted. Designated public access areas to the shoreline are limited and are identified in the Map Addendum. Shellfish harvesting represents about 2 percent of the $6.9 million recreational fishing value. Individual area use assessment is unknown. This fishery includes crabs, clams, oysters, and shrimp (NTPC 1978). Recreational razor clam collection is reported intensive between Grays Harbor and Taholah, on the Pacific coast. Other marine-related recreational activities include boating, scuba diving, beach combining, sightseeing, and picnicking.

An estimated one in ten residents of Washington owns a boat. Many shoreline parks include overnight moorage facilities.

Moorage in general is considered inadequate to meet demand. Although fishing or bird watching combine with boating activity and occur throughout the Strait, coast, and Puget Sound, boating for pleasure is particularly significant in the San Juan Islands and in the Whidbey and Camano Islands vicinity.

Over 400 state owned shoreline parks are found throughout the Strait and Sound area, having 12.8 million visits in 1978. An unknown number of county, city, or private parks are also located along the shore. The amount of use is generally unassessed.

There are numerous underwater parks along the Strait and in Puget Sound. Recreational scuba diving in these and other areas for shell and fin fish collection is increasing in popularity.

Hiking the trail along the Olympic National Park ocean beaches between the Hoh River and Ozette attracted 237,000 visits in 1978, about one-third of all trail use in the Olympic National Park. Campgrounds at Kalaloch, on the Hoh River, and at Mora (near LaPush) were used by 181,616 overnight campers in 1977 (Crawford pers. comm. 1979)

Openwater bird and mammal viewing from chartered boats in the Strait and Sound area is a new and increasingly popular activity. These trips, which frequently have a naturalist on board, attract both residents and non-residents.

Non-Marine Recreation

No recreational use is presently occurring within the proposed Low Point onshore storage facility site boundaries. The Lyre River Campground, a small state campground, is located within 1 mile on the east side of Lyre River and is experiencing an average of 5 percent growth each year. Between June and October of 1978, approximately 930 people used the campground; winter visits are unrecorded and minor. The campground has a one-half mile trail for access to the beach. An additional small, public day use area and a private campground is located on the west side of the Lyre River. Beach access from the private campground makes ocean views of the Strait available.

ECONOMIC CONDITIONS

This section describes the Clallam County economy: employment trends, economic base, wages and personal income, land values, and property taxes. Since the primary economic impacts occur in Clallam County, the county is the focus of the following discussion.

TABLE 8.4.2-15 1970 TO 1977 EMPLOYMENT AND UNEMPLOYMENT IN CLALLAM COUNTY

Employment	1970	1971	1972	1973	1974	1975	1976	1977	Percent Change 1970 to 1977
Civilian labor force									
Clallam County	13,580	14,160	14,930	16,150	16,560	16,240	16,170	18,440	35.8
State of Washington	1,410,000	1,400,000	1,425,000	1,463,000	1,508,000	1,532,000	1,547,800	1,641,000	16.4
Clallam as percent of state	0.96	1.01	1.05	1.10	1.10	1.06	1.04	1.12	
Total employment									
Clallam County	12,450	12,850	13,690	14,850	15,350	14,410	14,580	16,450	32.1
State of Washington	1,281,000	1,258,000	1,289,000	1,248,00	1,400,000	1,386,000	1,410,700	1,641,000	28.1
Clallam as percent of state	0.97	1.02	1.06	1.10	1.10	1.04	1.03	1.10	
Total unemployment									
Clallam County	1,130	1,130	1,240	1,300	1,210	1,830	1,590	1,990	76.1
State of Washington	129,000	142,000	136,000	115,000	108,000	146,000	137,100	144,000	11.6
Clallam as percent of state	0.87	0.92	0.91	1.13	1.12	1.25	1.16	1.38	
Unemployment Rate									
Clallam County	8.3	9.3	8.3	8.0	7.3	11.3	9.8	10.8	
State of Washington	9.1	10.1	9.5	7.9	7.2	9.5	8.9	8.8	

Source: TMC 1978

Employment Trends

Recent trends in civilian labor force size, employment, and unemployment in Clallam County are shown in table 8.4.2-15. For comparative purposes, data for Washington State have also been included in this table. From 1970 to 1977, Clallam County's civilian labor force increased with rather wide fluctuations from 13,580 to 18,440. A particularly sharp increase occurred between 1976 and 1977. From 1970 to 1977, the county's civilian labor force increased by 36 percent, over double the state increase of 16 percent. In 1977, the Clallam County civilian labor force constituted approximately 1.1 percent of the total state labor force.

Since 1973 the unemployment rate in Clallam County has been consistently above the state average. In 1977, the state average was 8.8 percent, while Clallam County had an unemployment rate of 10.8 percent. Unemployment in Clallam County shows a tendency for seasonal variation (table 8.4.2-16). Higher unemployment rates are typical during the winter months while rates during the period from late spring through early fall are lower. This seasonal variation is attributed to the nature of the county economy, which is highly dependent on the forest products industry and tourism (NTPC 1978).

Economic Base

The economy of Clallam County is dependent on natural resources. Scenic attractions, recreational opportunities, moderate climate, and marine resources attract tourists, retired persons, and fishermen. While the relative importance of these latter three population groups is not directly identified in traditional employment statistics, the presence of these groups is felt through demands placed on the service, trade sectors, and other economic sectors.

A breakdown of employment by industry is shown in table 8.4.2-17. A comparison of the data in this table with the total employment estimates (table 8.4.2-15) indicates that covered employment in 1976 represented about 80 percent of total employment in Clallam County. Based on the data for covered employment, some general conclusions can be made regarding the county's economy. Manufacturing forms the basis of the Clallam County economy, although its percentage share of total covered employment has steadily decreased from 42 percent in 1970 to 34 percent in 1976. Within the manufacturing sector, the timber industry is dominate. In 1970, lumber, wood products, and paper provided over 3,000 jobs, or 93 percent of all manufacturing employment and nearly 40 percent of all covered employment.

The economy of Clallam County is largely tied to its natural resource base. Three specific resource-oriented industries are discussed in detail below: forest products, tourism, and commercial and sport fishing.

TABLE 8.4.2-16 PERCENT OF UNEMPLOYMENT BY MONTH FOR CLALLAM COUNTY

Months	1970	1971	1972	1973	1974	1975	1976
January	10.0	14.9	10.9	10.8	10.5	11.1	10.5
February	9.0	11.4	11.8	8.8	8.5	12.7	11.2
March	8.3	10.7	7.2	7.9	7.7	13.1	11.7
April	6.2	8.2	7.1	7.7	6.8	11.0	10.2
May	6.4	11.0	7.1	6.4	6.0	10.4	9.2
June	7.4	8.6	7.5	7.3	5.4	10.1	9.1
July	9.5	9.0	8.4	7.8	6.2	10.4	8.8
August	7.6	8.3	7.5	8.3	5.7	9.3	8.4
September	7.2	7.3	7.1	7.3	5.5	10.3	9.1
October	7.7	6.7	6.6	6.8	6.5	11.2	9.8
November	10.3	7.9	7.5	8.6	9.3	13.0	10.1
December	10.1	7.5	10.9	9.1	10.3	13.3	11.2
Annual Average	8.3	9.3	8.3	8.0	7.3	11.3	9.9

Source: TMC 1978

TABLE 8.4.2-17 COVERED WAGE AND SALARY EMPLOYMENT IN CLALLAM COUNTY

Employment	1970	1971	1972	1973	1974	1975	1976
Agriculture and forestry	EXC1/	76	71	74	98	97	134
Mining	22	22	23	26	23	19	21
Contract construction	419	426	459	538	658	607	562
Manufacturing	3,221	3,026	3,373	3,673	3,750	3,498	4,039
Food and kindred products	103	87	72	61	82	73	57
Lumber and wood products	1,910	1,939	2,290	2,635	2,606	2,374	2,835
Paper and allied products	1,096	875	877	EXC	EXC	EXC	EXC
Printing and publishing	73	76	79	82	92	96	108
Stone, clay and glass products	26	25	27	29	32	30	29
Machinery Except electrical	EXC	9	10	12	17	18	19
Other manufacturing	13	15	18	854	921	907	991
Transportation, communications, and utilities	494	439	508	625	627	558	651
Trade	1,920	2,024	2,245	2,484	2,573	2,621	2,777
Finance, insurance, and real estate	288	325	356	382	433	387	472
Services	1,108	1,171	1,399	1,452	1,567	1,763	1,890
Government	EXC	849	1,233	1,252	1,396	1,524	1,459
Not otherwise reported	182	0	1	0	0	0	0
Total	7,654	8,358	9,608	10,506	11,125	11,074	12,005

Source: TMC 1978

1/ EXC means excluded from employment estimate or placed in another industrial category due to nondisclosure policies.

TABLE 8.4.2-18 COMMERCIAL FOREST LAND IN CLALLAM COUNTY

Ownership	Acres
Public	
Olympic National Forest	189,838
State forest land	135,373
Indian timberlands	27,000
Total	352,211
Private	
ITT Rayonier	107,650
Crown Zellerbach	77,795
Milwaukee Land Company	27,075
M&R Timber	28,900
Peninsula Plywood	10,000
Bloedell	8,691
Longview-Fibre	8,600
Small ownerships	62,972
Total	331,683
Total (public and private)	683,894

Source: TMC 1978

Forest Products

The timber industry is considered to be the mainstay of Clallam County (TMC 1978). According to county estimates, approximately 61 percent of all land in Clallam County is devoted to commercial timberland by owner. Table 8.4.2-18 shows the distribution of commercial timberland by owner. Approximately 52 percent of the timberland is under public ownership, with the federal government being the largest public owner. The remaining 48 percent is privately held land, with ITT Rayonier being the largest private owner.

Major forest products companies in Clallam County are identified in table 8.4.2-19, along with estimates of their respective employment and payrolls. The five companies show an estimated 1974 employment level of over 2,000, with a total payroll in excess of $31 million. Total wage and salary disbursements in Clallam County were $117.9 million in 1974. These five companies contributed about one-fourth the total county payroll; they constituted about 18 percent of total covered employment in 1974.

TABLE 8.4.2-19 MAJOR FOREST PRODUCT COMPANIES IN CLALLAM COUNTY IN 1974

Firm	Product	Employment	Payroll (millions)
ITT Rayonier	Chemical cellulose	726	$12.37
Port Angeles		500	8.76
Forks		226	3.61
Crown Zellerbach	Newsprint paper	634	9.16
Port Angeles		436	6.00
Clallam Bay - Sekiu		198	3.16
Peninsula Plywood	Plywood	411	5.40
M&R Timber Company	Dressed lumber	200	3.20
Neilson Logging Company	Logs	43	0.96
Total		2,014	31.09

Source: TMC 1978

Tourism

Tourism is an important industry in Clallam County. The attraction of Clallam County is largely due to scenic features and recreational areas. The county's most prominent attraction is Olympic National Park with 2.6 million visits recorded in 1977. Park attendance is seasonal, with 80 percent of the visits between April and September.

Another gross index of the importance of tourism is shown by statewide hotel and motel sales data. Clallam County was ranked 11 of 39 counties in the state for total hotel and motel sales in 1976 and 8 for the number of hotel and motel units. Total 1976 lodging sales in Clallam County were $4.6 million. There were 1,074 hotel and motel units in the county in 1976 (TMC 1978).

Fishing

Clallam County contains approximately 222 miles of marine shoreline as well as many miles of rivers and streams. Water bodies in and around Clallam County are rich with marine and aquatic resources that support commercial and sport fishing.

The annual catch of fish and shellfish on the Washington side of the Strait is valued at $11.2 million and the catch for the whole of Puget Sound and the Strait combined is valued at $74.6 million. Table 8.4.2-20 shows fishery production and harvest estimates. Production is taken to be the same as catch or harvest with the exception of salmon production which represents the escapement measured in equivalent terms from spawning streams tributary to the area. See chapter 2 for additional information.

TABLE 8.4.2-20 PRESENT 1/ FISHERY PRODUCTION, SELECTED INLAND WATERS OF WASHINGTON
(Thousands of Dollars, 1976 Prices to Fishermen Except as Noted)

	Strait of Juan de Fuca 2/	Hood Canal	Central Puget Sound	South Puget Sound	Puget Sound Total 3/
Shellfish	1,264	3,003	4,177	5,798	21,917
Commercial bottomfish	260	263	17	140	1,187
Recreational bottomfish 4/	51	511	281	10	976
Salmon production 5/	1,958	8,833	5,545	4,163	35,380
Herring	—	—	224	146	16,060
Total	3,533	12,610	10,244	10,257	61,060
Salmon harvest	9,588	6,586	3,493	1,672	48,959

Source: Washington Department of Fisheries 1978

1/ Annual data for various years selected to represent typical values. Shellfish represent average production over 5-year period, 1972-1976. Bottomfish are 1976 data. Salmon production and harvest are based on 1975 commercial catch and 1976 recreational catch. Herring are 1976 catch (about one-half 1975 catch in South Sound and Hood Canal).

2/ For shellfish, includes area from Port Angeles to Port Townsend.

3/ Includes Strait of Juan de Fuca and Washington portions of Puget Sound.

4/ Valued at equivalent retail value of filleted fish.

5/ Excludes production in Puget Sound tribal and cooperative projects. Production represents value by spawning area rather than harvest area.

Wages and Personal Income

Recent trends in per capita personal income are listed in table 8.4.2-21. The per capita income for Clallam County increased by nearly 65 percent over the period from 1969 to 1975.

TABLE 8.4.2-21 CLALLAM COUNTY PER CAPITA PERSONAL INCOME FOR 1969 to 1975 1/

Area	1969	1974	1975	Percent Change 1969 to 1975
Clallam County	$3,433	$5,267	$5,650	64.6
State of Washington	3,982	5,648	6,284	57.8
County as percent of state	86.2	93.3	89.9	

Source: TMC 1978

NOTE: Personal income consists of private and government wage and salary payments in cash and in kind, other labor income, farm and non-farm proprietors° income, interest, net rents, dividends, and transfer payments, less personal contributions for social insurance. It is measured before the deduction of personal income and other personal taxes and is reported in current dollars (no adjustment is made for price changes).

Annual average wages by industry are listed in table 8.4.2-22. State averages are listed also. The average employee in a Clallam County covered job earned an annual wage of $10,570. The highest paying sectors were manufacturing ($14,435) and transportation and utilities ($13,220). The lowest paying sector was services ($6,233) followed by agriculture, forestry, and fishing ($6,742). In almost every single industry category, employees in Clallam County received less in wages than did statewide counterparts.

TABLE 8.4.2-22 CLALLAM COUNTY ANNUAL AVERAGE WAGES BY INDUSTRY

Employment	Clallam County	State of Washington	Clallam as Percent of State
Agriculture, forestry, and fishing	$ 6,742	$ 9,842	68
Mining	12,608	15,574	81
Construction	12,136	15,258	79
Manufacturing	14,435	14,541	99
Food and kindred products	10,829	12,046	90
Lumber and wood products	13,723	14,140	97
Printing and publishing	7,305	11,823	62
Stone, clay, and glass products	16,230	NA	NA
Machinery, except electrical	13,957	14,081	99
Transportation equipment	8,910	17,190	52
Other manufacturing	17,543	14,267	123
Transportation and public utilities	13,220	15,051	88
Wholesale trade	11,588	13,449	86
Retail trade	6,942	7,339	95
Finance, insurance, and real estate	8,140	10,252	79
Services	6,233	8,607	72
Government	10,888	13,365	81
Weighted average	10,570	11,521	92

Source: TMC 1978

Land Values

In 1977, residential land values in Port Angeles were about $24,000 per acre, with the average parcel size being a quarter acre. (see table 8.4.2-23). Land values outside of Port Angeles tend to be substantially lower. Larger land parcels (20 acres) for residential purposes are valued at about $2,000 per acre, while smaller parcels (5 acres or less) have a value of approximately $5,000 per acre. Agricultural land and timberland not suitable for residential uses have substantially less value.

TABLE 8.4.2-23 CLALLAM COUNTY LAND VALUES IN 1977

Area	Residential Land (Estimated Value per Acre)	Agriculture Land (Estimated Value per Acre)	Timberland (Estimated Value per Acre)
Clallam County	$2,000 to $5,000	$1,500 to $2,000	$1 to $100
Port Angeles	$24,000	—	—

Source: TMC 1978

It is probable that there is large variation in land values throughout Clallam County. A 1974 survey indicated that the aesthetic and recreational premiums attached to waterfront property in unincorporated parts of Clallam County range from an average of $80 to $132 per front foot (TMC 1978). The high end of the range was associated with prime waterfront land having no significant impediments to residential development with beach access. The lower end of the scale reflected those waterfront properties without a beach.

Property Taxes

A comparison of assessed valuations in Clallam County with statewide figures is shown in table 8.4.2-24. The county's assessed valuation has expanded at an annual rate of 9.4 percent from 1976 to 1978. The total assessed valuation of Clallam County was $713.8 million in the 1978 tax year or 1.2 percent of the total assessed valuation of Washington. The recent growth in the county's tax base has lagged behind that of the state.

TABLE 8.4.2-24 ASSESSED VALUATIONS IN CLALLAM COUNTY 1/

Area	1976	1977	1978	Annual Rate of Change 1976 to 1978 (Percent)
		(Thousands)		
Clallam County	$ 596,074	$ 639,064	$ 713,809	9.4
State of Washington	45,206,880	51,321,281	59,168,258	14.4
Clallam County as percent of state	1.3	1.2	1.2	

Source: EFSEC 1978.
1/ Based on year taxes due.

The amount of property taxes paid by an individual taxpayer in Clallam County depends not only on the assessed valuation of personal property, but also the location of the property with respect to the taxing districts. In the 1978 tax year, the total levy ranged from $9.10 to $16.33 per thousand dollars of assessed valuation, with the average being $15.49. The average total levy statewide was $16.94 per thousand dollars of assessed valuation. Tax rates for each of the various taxing districts in Clallam County are shown in table 8.4.2-25. In certain districts, a range is identified. This indicates that the rate will vary depending on one's location within the district.

TABLE 8.4.2-25 1978 TAX RATES IN CLALLAM COUNTY

Taxing District	Tax Rate (Dollars per $1,000 Assessed Valuation)
Cities and Towns	
Port Angeles	3.42 to 3.51
Sequim	3.35
Forks	3.01
School Districts	
School District 121	4.65 to 10.49
School District 313	4.65 to 10.99
School District 323	4.65 to 9.82
School District 401	4.65 to 9.47
School District 402	4.65 to 8.86
Fire Districts	
Fire District 1	0.30
Fire District 2	0.67
Fire District 3	0.90
Fire District 4	0.32
Fire District 5	0.61
Hospital Districts	
Hospital District 1	0.50 to 0.86
Hospital District 2	0.19 to 0.28
Other Districts	
Road District	1.97
Library District	0.41
Port District	0.22
Park and Recreation District 1	0.02 to 0.03
Clallam County	1.66 to 1.79
Total Tax Levy Range	9.10 to 16.33
Average Total Tax Levy	15.49

Source: TMC 1978

SOCIAL CONDITIONS

Of the approximately 260,000 people that live along the Strait of Juan de Fuca, about 220,000 live on the southern part of Vancouver Island in British Columbia, primarily in the vicinity of Victoria. Approximately 40,000 people live along the northern edge of the Olympic Peninsula of Washington with the highest population density occurring in the vicinity of Port Angeles.

Population

Clallam County had an estimated 1978 population of 44,240. Port Angeles accounts for about 39 percent (17,205) of the county's current population. The remaining two incorporated cities, Sequim and Forks, make up 22 percent. The others live in unincorporated sections of the county, primarily between the Strait of Juan de Fuca and Olympic National Park.

Between 1973 and 1978 Clallam County showed substantial population growth, expanding from 35,200 to 44,240. This growth has occurred mostly in the unincorporated portions of the county, which reversed the trend of a few years earlier. From 1973 to 1978 Port Angeles grew from 16,765 to 17,205, an annual growth rate of .52 percent. In contrast, the unincorporated portions of the county experienced a 33 (6.6 percent annually) percent increase in population. County population as a whole expanded by approximately 26 percent and municipal population trends (5.2 percent annually) are shown in table 8.4.2-26.

Average gross population density of the county is less than 25 persons per square mile. However, approximately 89 percent of the county's land area is owned by federal and state government and private timber concerns. When these areas are subtracted from the county's total acreage, the effective average density of Clallam County exceed 200 persons per square mile.

TABLE 8.4.2-26 COUNTY AND MUNICIPAL POPULATION TRENDS 1930 to 1977

Location	1930	1940	1950	1960	1970	1971	1972	1973	1974	1975	1976	1977
Clallam County	20,449	21,848	26,396	30,022	34,770	34,900	35,100	35,200	35,800	37,000	39,800	41,100
Port Angeles	10,188	9,409	11,233	12,653	16,367	16,450	16,600	16,765	16,600	16,242	16,506	16,800
Sequim	NA	676	1,044	1,164	1,533	1,560	1,794	1,900	2,322	2,425	2,510	2,555
Forks	NA	NA	1,120	1,156	1,692	1,713	1,734	1,788	1,867	1,893	1,948	2,030
Unincorporated	NA	NA	12,999	15,049	15,178	15,177	14,972	14,747	15,011	16,440	18,836	19,625
Unincorporated as percent of total	NA	NA	49	50	44	43	43	42	42	44	47	48

Source: 1930 to 1970: Clallam County Overall Economic Development Committee 1977
1971 to 1977: Office of Program Planning and Financial Management 1978
NA means not available.

Infrastructure

There were 17,215 year-round dwelling units in Clallam County in 1977, half of which were located in the incorporated cities of Port Angeles, Sequim, and Forks (table 8.4.2-27). The overall vacancy rate for the county is estimated to be 4.7 percent, 62 percent of which are located outside the cities (Clallam County Governmental Conference 1977). There is no specific information currently available that identifies how many vacant units were available for rent versus those available for sale.

In addition to the year-round housing stock, there are an estimated 1,000 units or rooms available for transient accommodations in Clallam County (table 8.4.2-28). Approximately 80 percent of these rooms are in motels. A survey of hotels and motels in eastern Clallam County was conducted by the Clallam County County Governmental Conference in 1977. The results of this survey are presented on table 8.4.2-29.

A comparison of the survey sample with the total county inventory (table 8.4.2-28) indicates the survey covered accommodations in the county and approximately 75 percent of all transient rooms in the county. The survey showed that vacancy rates from June through September are average 2.1 percent. During the remaining 8 months, the vacancy rate is about 50.4 percent. If these vacancy rates are applied to the estimate of the total number of transient accommodations in Clallam County, approximately 500 units would be vacant from October through May and only 21 units from June through September.

TABLE 8.4.2-27 ESTIMATED CLALLAM COUNTY HOUSING

Area	Total Year-Round Dwelling Units	Occupied Units	Vacant Units	Vacancy Rate
Clallam County	17,215	16,411	804	4.7%
Port Angeles	6,776	6,453	323	4.8%
Sequim	1,255	1,197	58	4.6%
Forks	644	633	31	4.7%
Unincorporated	8,520	8,128	392	4.6%

Source: TMC 1978

TABLE 8.4.2-28 INVENTORY OF TRANSIENT ACCOMMODATIONS IN CLALLAM COUNTY FOR 1977

Type of Accommodation	Number Of Accommodations	Number of Units with Toilet and Bathing Facilities
Hotel	3	72
Resort	14	46
Motel	33	811
Other	1	
Unknown	1	
Total	52	929

Source: TMC 1978

TABLE 8.4.2-29 HOTEL AND MOTEL SURVEY RESULTS

Total firms surveyed	26
Total number of units identified	754
Number of units currently available for semi-permanent or permanent occupancy	125
Number of persons occupying semi-permanent or permanent units	103
Number of units available for temporary or vacation-type transient occupancy only	629
Months considered the "off season"	
Major response	November through March
Range of response	late September to late May
Average occupancy during "off season"	
Range of response (of those open)	20 to 100 percent
Average occupied rooms	374/754 = 49.6 percent
Months considered the "busy season"	
Majority response	June through September
Range of response	early April to mid October
Average occupancy during "busy season"	
Range of response	75 to 100 percent
Average occupied rooms	735/754 = 97.9 percent
Number of units proprietors would be willing to make available on a semi-permanent or permanent basis to house construction workers during construction of a local project	
During the "off season"	183 rooms
During the "busy season"	47 rooms (at full rates only)

Source: Clallam County Governmental Conference 1977

The Clallam County survey reported that hotel and motel operators would be reluctant to house construction workers on a semi-permanent basis. Findings of the survey showed that they would make 183 rooms available from October through May, and 47 rooms from June through September (Clallam County Governmental Conference 1977).

The main water supply for Port Angeles is the Elwha River, which provides the city with 13 to 14 million gallons per day (mgd). The system is capable of meeting the needs of a population up to 24,000 (SRI International 1978). Port Angeles has another water supply line from the Elwha River, capable of furnishing 65 million gallons of untreated water per day for industrial uses. All of that water is currently being used by wood processing plants in the city (SRI International 1978).

The onshore storage facility site at Low Point is in an area served by the Crescent Water Association, a private water district with surface water rights at three springs and the Lyre River. The Crescent Water Association has a minimum available reserve capacity of 515,000 gpd (NTPC 1978). There are 290 residential connections and 5 other (unspecified) connections served by this water association (NTPC 1978).

County wastewater treatment via sewerage systems and treatment facilities is limited to the areas of Port Angeles, Sequim, and Clallam Bay/Sekiu. The Port Angeles system is the largest with a peak load design of 10.1 million gallons per day (mgd), and can accommodate a population of 24,000. The treatment facility has a peak (primary treatment only) capacity of 3.9 mgd and an average capacity of 7.2 mgd. Forty to 50 percent of the systems' capacity remains available for additional connections, but sewer lines to the new customers would need to be laid (Clallam County Governmental Conference 1977). Federal law required a secondary treatment system as of July 1, 1977. However, the plant probably will not be upgraded until 1980 or later, when grant monies are expected to be made available to the city (SRI International 1978).

The Sequim area has a smaller sewerage system and treatment facility, designed for a peak load of 570,000 gallons per day (gpd). Maximum flows run to 500,000 gpd, while the average is 257,000 gpd; leaving a remaining average capacity of over 350,000 gpd, but only 70,000 gpd remaining peak capacity. This system is in violation of Federal laws as of July 1, 1978, for lack of secondary treatment.

The Clallam Bay/Sekiu area has the remaining major sewerage system with two separate sewage treatment facilites. The Clallam Bay facility has a 80,000 gpd peak design load. Current data shows a maximum flow of 47,000 gpd and an average of 45,000 gpd with remaining capacities of 33,000 gpd and 35,000 gpd respectively. The Sekiu facility has a peak design load of 130,000 gpd. Current data shows a maximum flow of 20,000 gpd and an average flow of 10,000 gpd with remaining capacities of 110,000 gpd and 120,000 gpd respectively.

The two facilities have been in operation since September 1976. Both systems include secondary treatment and are in compliance with water quality requirements of July 1, 1977 (Clallam County Governmental Conference 1977).

Clallam County continues to address the solid waste disposal problem. Land fills continue to be the only solution; two fills are in operation. The Port Angeles landfill is located at the western edge of the city and currently serves Clallam County from the Lake Crescent area east to the Jefferson County line. Solid wastes, currently monitored by weight, are being added to the land fill at a rate of 19 million tons per year. Figures on the total capacity of the site were not available. A 50-year life was estimated by one site administrator but supporting documentation was not provided. Even with a 50 percent error margin in that estimate, there appears to be no short-term capacity problem (Clallam County Governmental Conference 1977).

The Lake Creek landfill is located near Lake Creek and Highway 101 in western Clallam County. It currently serves that area west of Lake Crescent to Jefferson County southwest of Clallam County. Input to the site is an estimate system of weight. These estimates yield an input of 6 million tons per year. Total site capacity is a function of gravel removed. No estimate was available on the life of the site.

In addition to the land fills, two transfer sites function as more convenient collection locations in the county area. The Blue Mountain site serves the east end of the county and the Olympic Disposal Company serves the northwestern portion of the county. The materials collected at these sites are taken to the Port Angeles and Lake Creek landfills, respectively (Clallam County Governmental Conference 1977).

Eastern Clallam County is served by three public school districts: Port Angeles, Crescent, and Sequim, described in table 8.4.2-30. There are nine public elementary schools, seven public secondary school (junior high/middle schools and senior high schools), and two private schools in these three districts.

The Port Angeles district has the largest number of facilities and the greatest enrollment. The data in table 8.4.2-30 indicate that as of October 1, 1977, this district had insufficient classroom space in grades K to 5 and 9 through 12. This condition is projected to continue in grades K to 5, where increasing enrollments are anticipated in 1980 and 1982. However, enrollments in grades 9 to 12 are expected to decline, with sufficient capacity available by 1980 (Clallam County Governmental Conference 1977). The Port Angeles schools currently have excess capacity in grades 6 to 8. The staff-pupil ratios are generally comparable to the statewide averages in districts with comparable enrollment. The Port Angeles school district recently passed a school construction bond issue.

The Crescent district, with an enrollment of only 294 students as of October 1, 1977, serves an area west of Port Angeles. This district currently has a shortage of elementary classroom space and a surplus of secondary school space. These conditions are expected to continue through 1982 if no new schools are built. The ratio of professional staff per pupil in the Crescent district is slightly lower in the elementary grades and substantially lower (33 fewer professional staff per thousand students) in the secondary grades than the statewide average for schools in districts of comparable size. This staff differential probably explains why 1976-77 expenditures per pupil in the Crescent district were about $300 less per year than the average in districts with smaller enrollments.

The Sequim district serves the easternmost portion of Clallam County. As shown in table 8.4.2-30, this district has a sizeable shortage of space in the elementary and middle schools: deficits of 452 seats in grades K to 4 and 177 seats in grades 5 to 8. Expansion of the elementary school to 600 seats is due to be completed in August 1979. A similar expansion is planned for the middle school, with total capacity of 620 seats to be available for the 1980-81 or 1981-82 school years. There is currently a surplus of about 100 classroom spaces in the senior high school that

TABLE 8.4.2-30 CHARACTERISTICS OF PUBLIC SCHOOL DISTRICTS SERVING EASTERN CLALLAM COUNTY

School District	School Type 1/	School Grade	School Number	Capacity	Enrollment October 1977	Projected Enrollment 1980	Projected Enrollment 1982	Professional Staff per 1,000 Pupils 2/	Statewide Average Professional Staff per 1,000 Pupils for Districts with Comparable Enrollments	District Expenditures per Pupil 3/ (dollars)	Statewide Average Expenditures per Pupil for Districts with Comparable Enrollments (dollars)
Clallam County											
Port Angeles (Number 121)	E	K-5	7	1,651	1,908	2,114	2,211	41.79	48.03		
	J	6-8	3	1,276	1,032	1,050	1,150	52.81	51.34	1,438	1,429
	S	9-12	1	1,587	1,706	1,508	1,412	49.56	49.96		
	P	NA 4/	1	NA	185	NA	NA	NA			
Crescent (Number 313)	E	K-6	1	110	140	152	160	74.72	69.94		
	J/S	7-12	1	124	154	148	169	60.90	94.72	1,563	1,850
Sequim (Number 323)	E	K-4	1	122 5/	574	600	630	47.36	47.71		
	J	5-8	1	354 6/	531	604	614	43.21	45.77	1,230	1,413
	S	9-12	1	760	669	637	660	47.52	53.36		
	P	NA	1	NA	106	NA	NA	NA			

Source: Clallam County Governmental Conference 1977

1/ E = elementary, J = junior high school or middle school, S - senior high school, P = private school.

2/ Professional staff includes all certified school staff members such as teachers, administrators, guidance counselors, librarians, and so forth. Figures in this colume represent 1976 to 1977 school year values.

3/ Statistics on per pupil expenditures are for 1976 to 1977 school year (WPSI 1970).

4/ NA = data not available.

5/ Capacity will be 600 as of the 1979-1980 school year.

6/ Capacity will be 620 in the 1980-1981 or 1981-1982 school years.

is expected to continue through 1982. Staff-pupil ratios are roughly comparable to those in districts of similar size, with middle school and high school ratios slightly lower. Expenditures per pupil were about $180 less during the 1976 to 1977 school year than the statewide average for districts with comparable enrollments. The Sequim school district passed a bond issue in 1977. One new school was scheduled to open in 1978 and two more are planned, increasing school capacity by 30 percent.

The two private schools in the area are: Queen of Angeles, serving Port Angeles residents, with an enrollment of 185 students in grades K to 8 and another school serving Sequim residents, with 106 students. The study area also includes Peninsula Community College, a public 2-year college located in Port Angeles.

This area is located in the Olympic Health District, which includes Clallam and Jefferson Counties, and is served by three hospitals: Olympic Memorial Hospital in Port Angeles, Jefferson General Hospital in Port Townsend, and Forks Community Hospital in Forks. Table 8.4.2-31 describes these hospitals, their capacities, and service areas. Residents of both Clallam and Jefferson Counties use these hospitals. Patients who require services beyond those offered at these hospitals are generally transferred to hospitals in Seattle or Bremerton. Emergency transportation in the district is provided by five ambulances.

TABLE 8.4.2-31 CHARACTERISTICS OF HOSPITALS IN THE OLYMPIC HEALTH DISTRICT

Facilities and Service Characteristics	Olympic Memorial (Port Angeles)	Jefferson General (Port Townsend)	Forks Community (Forks)
Service area	All Clallam County	Eastern Clallam and Jefferson Counties	Western Clallam and Jefferson Counties
Number of general care beds	86	42 (1977) 31 (1978)	30
Number of ICU/CCU beds 1/	8	2	2
Number of doctors on staff	30	9	6
Occupancy rate, 1977	72 percent	32 percent	4 percent
Patient days per year	22,715	4,927	1,533

Source: TMC 1978

1/ ICU - intensive care unit
CCU - coronary care unit

Existing hospital facilities for Clallam and Jefferson Counties appear to be more than adequate, given the existing availability of hospital beds (TMC 1978).

Since July 1, 1978, Olympic Memorial Hospital's emergency room has been manned 24 hours per day, 7 days per week. This hospital participates with fire protection, law enforcement, civil defense, and other agencies in disaster planning. Port Angeles has a disaster plan reviewed yearly with mock drills held twice a year.

The hospital also has mutual aid agreements with all hospitals and nursing homes in the area. It has a helicopter and heliport that are used twice weekly, primarily to transfer patients to Seattle or elsewhere. Olympic Memorial Hospital does not perform complex neurosurgery, open heart or other major surgery (TMC 1978).

Another criterion for judging adequacy of health care services is the ratio of primary care physicians to residents in the service area. Primary care physicians include general practitioners, family practice doctors, pediatricians, obstetricians/gynecologists, and general internists. The federal standard for adequate service is one primary care physician for every 2,000 residents served. Anything less than one primary care physician per 3,500 residents represents inadequate service. These ratios are used by the National Service Corps (part of U.S. Dept. of Health, Education and Welfare) to upgrade service in shortage areas.

In 1977, Clallam County had one primary care physician for every 1,840 residents; representing an adequate level of service; Jefferson County had one primary care physician for every 3,750 residents; representing an inadequate level of service (TMC 1978).

Law enforcement in Clallam County is provided through three municipal departments, one county system, one state system, and one security guard system. Included in table 8.4.2-32 are characteristics of the law enforcement agencies.

The Port Angeles Police Department has 20 full-time officers and 14 reserves, with six patrol cars. The national average for fulltime law enforcement officers in communities of 10,000 to 25,000 residents is 1.6 officers per thousand residents. Using 1978 population figures, Port Angeles currently has 1.16 full-time officers per thousand residents, below the national average.

TABLE 8.4.2-32 SUMMARY OF POLICE PROTECTION FOR CLALLAM COUNTY

Force	Patrolmen	Reserves	Patrol Cars	Detention Facilities Capacity	Average Occupancy
City of Sequim	5	9	2	Holding Room Only	In Port Angeles Data
City of Port Angeles	20	14	6	34 beds	20
City of Forks	6	3	3	7 beds	7+
Clallam County	17	19	15	Uses Port Angeles Facilities	In Port Angeles Data
Washington State Patrol	9	0	9	Uses Port Angeles Facilities	In Port Angeles Data

Source: Clallam County Governmental Conference 1977

National standards specify there should be one patrol car for every three officers, or 0.5 to 0.67 cars per thousand residents in the area served. The Port Angeles Police Department has one car for every 3.3 officers, and 0.35 cars per thousand residents. While the number of cars is sufficient for the number of officers, three more cars are needed to meet the standard of 0.5 car per thousand residents.

The Clallam County Sheriff's Department currently consists of 17 deputies and 19 reserves, with 15 patrol cars. Of the 17 deputies, 5 serve the west county, 11 serve the east, and 1 acts as the sole detective for the county (Clallam County Governmental Conference 1977). Currently, across the county, there are 0.87 officers per thousand residents of unincorporated areas. A figure of 1.5 officers per thousand residents is the national average for county sheriff departments. There are currently 0.76 cars per thousand residents of unincorporated areas, or one car per 1.13 officers; the number of patrol cars is more than adequate for the population of the county.

Fire protection to Clallam County residents is provided through five districts and three municipal departments as detailed on table 8.4.2-33.

The Port Angeles Fire Department has a staff of 13 paid professional and 20 volunteers. Equipment includes three pumper trucks, one combination ladder-pumper truck, one rescue truck, and three small vehicles. The Washington Surveying and Rating Bureau, an independent organization that evaluates fire protection services for the purpose of setting fire insurance premiums, has graded Port Angeles in protection classification 5 on a scale of 1 to 10. Class 1 represents the highest relative level of fire defense, and class 10 represents the lowest relative level of fire defense (Clallam County Governmental Conference 1977).

According to fire flow standards set by the Washington Surveying and Rating Bureau, the three pumpers and one combination ladder-pumper trucks presently in use indicate that the Port Angeles Fire Department has the equivalent of firefighting apparatus needed to respond to the largest likely fire. However, the available staff is slightly below the standard.

Clallam County Fire Protection District 3 is one of five such volunteer fire protection districts serving unincorporated areas in Clallam County. District 3 has four fire stations at Carlsborg, R Corner, Dungeness, and Diamond Point. The district is staffed by 75 volunteers, and equipment includes six pumpers, three tankers, and one first aid vehicle, as indicated in table 8.4.2-33. A fifth station, the Lost Mountain Volunteer Fire Brigade, is presently being organized and was reported to have obtained a pumper truck and to have recruited some volunteers (TMC 1978). The Washington Surveying and Rating Bureau grades District 3 in protection class 8, with all district in zones 2 through 4, indicating that fire hydrants are not generally available.

TABLE 8.4.2-33 FIRE PROTECTION SERVICES IN CLALLAM COUNTY

Department Fire Protection Agenty	Number of Full-Time Personnel	Number of Volunteer Personnel	Number of Pieces of Equipment	Rating (class)
Port Angeles	13	20	3 pumpers 1 ladder/pumper 1 rescue truck	5
Clallam County District 3	1	80	6 pumpers 3 tankers 2 aid vehicles	8 Zones 2, 3, and 4
Clallam County District 2				8
Dry Creek	0	12	2 pumpers	8
Gales Addition	0	16	2 pumpers	Zones 2, 3, and 4
Clallam County District 4	0	6	2 pumpers	9 Zones 1 and 2
Sequim	0	20	1 pumper (belongs to District No. 3) 1 equipment truck	6

Source: Clallam County Governmental Conference 1977

The required water flow in Clallam County Fire Protection District 3 is about 3,000 gpm. The district's six pumpers and two tankers are sufficient to meet fire flow needs, but the time required for firefighters to reach parts of the district are too long. While the 75 volunteer personnel in the district represent the equivalent of 25 full-time members, more than enough to satisfy the specified staff needs, such volunteer staff credit can only be claimed for one-half the required strength. Ideally the district should have 8 to 10 paid firefighters on duty, with the balance of the staffing needs provided by volunteers.

The study area includes other fire protection agencies: Clallam County Fire Protection District 2 (including Dry Creek and Gales Addition), Clallam County Fire Protection District 4, and the Sequim Fire Department. The equipment, personnel, and rating of these departments are shown in table 8.4.2-33. The municipal department in Sequim has been rated class 6 by the Washington Surveying and Rating Bureau, while the two fire protection districts that serve unincorporated areas have been rated class 8 and class 9. Substantial areas in District 2 are in class 8, zone 3 (equivalent to class 9) and class 8, zone 4 (equivalent to class 10). The class 9 grade indicates that the nearest fire station is more than 2 miles away, and the class 10 grade represents areas that are effectively inaccessible for either equipment or personnel (Clallam County Governmental Conference 1977).

Makah and Lower Elwah Indian Reservations

Because of its location the proposed project will have effects on two local Native American Tribal Groups. These are the Makah, whose reservation includes 27,300 acres of the northwestern portion of Clallam County, and the Lower Elwha Tribal Community of the Clallam Indians, who have a 372-acre reservation approximately 12 miles east of the Low Point site.

Both groups, the Makah and Lower Elwha Band, are self-governing entities under the terms of the constitutions filed with and accepted by the federal government.

The Lower Elwha Reservation was officially established on January 19, 1968, by the Secretary of the Interior whose action transferred lands formerly held under U.S. ownership, to the Lower Elwha Tribal community. At the time this occurred, an estimated 135 persons were listed on the Tribal rolls. By 1978 the tribal roll included 250 individuals. In 1978 a total of 129 Native Americans lived on the reservation and 94 lived adjacent to it (Bureau of Indian Affairs 1978).

No recent housing survey information is available. However, housing vacancy rates undoubtedly are very low. Water for domestic use is obtained from wells installed and maintained by the U.S. Public Health Service. This agency also installed the sewer system serving the reservation.

Children from the reservation attend Port Angeles public schools. Medical and hospital service is provided contracturally in Port Angeles (Federal and State Indian Reservations, U.S. Department of Commerce 1976).

A council, consisting of five elected members, governs the Lower Elwha tribal community. Three of the council members serve in an executive capacity. A manager is employed by the tribe to oversee business activities.

In 1978 there were 1,005 Native Americans living on the Makah Reservation. An additional 23 lived adjacent to it (BIA 1979). This reservation was established in January 1855, enlarged to its approximate present size in October 1973, and placed under Makah Tribal jurisdiction in 1934.

Neah Bay is the most intensively developed portion of the reservation. A tribal planning document reported that there were about 224 "non government" residential dwellings in or adjacent to the community. Nearly 14 percent of these were mobilehomes. In addition there were 78 other residential structures used for housing federal employees. The vacancy rate for all structures in 1972, was 16 percent (Makah Reservation Comprehensive Plan 1972).

Prior to 1970 the water supply and sewer system in Neah Bay were deficient. However, new systems were designed and constructed. Makah children attend one of the three schools in the Cape Flattery district. Medical services are available at a clinic in Clallam Bay, at the hospital in Forks, or by contract in Port Angeles.

A council composed of five members governs the Makah Tribe. There also is an appointed tribal executive director responsible for implementing tribal council policies and programs.

Social Well-Being and Quality of Life

In Clallam County and Port Angeles, the level of social well-being, as measured by selected indicators, is conducive to residential stability. Population density is relatively high in both the County and City. But this high density is not due to crowding, rather it is the result of a limitation on the amount of land available for residential use. For example, only about 11 percent of the total county land area is presently available for residential use. The rest consists of either Federal and State lands, or privately owned forest lands. In Clallam County the estimated 1980 population density, on the lands that are available for residential use, is about 220 persons per square mile. Population density in Port Angeles is about 2,010 persons per square mile. Open land areas, particularly in Olympic National Park and Olympic National Forest, which are easily accessible to County and City residents, aleviates any impression, statistical or visual, of "crowding."

Population trends have produced a well-balanced population-age distribution pattern. In 1975 about 24 percent of the County residents were under 15 years of age; 15 percent were age 65 or older. Nearly 46 percent of the population was in the 25 to 64 year age bracket (State of Washington Population Trends 1977).

Unemployment, at 10.5 percent (1977) was high. Per capita income in 1975 was $5,650, lower than the statewide average of $6,24 (NTPC 1978).

County and City government and governmental services are generally responsive and receptive to residential needs. Support has been given to easing the presently crowded public school classroom facilities through bond approvals. A major program to improve the downtown Port Angeles business and harbor area was implemented in 1978.

City and County officials also have actively engaged in studies designed to measure and assess the potential effects that an oil port development might have. At the present time elected county officials oppose the development of oil port facilities in the Strait of Juan de Fuca.

The quality of life in Clallam County and Port Angeles, illustrated by selected indicators, is high and is satisfying to the residents. In a general sense the style of life is comfortable and relatively low pace of life, characteristic of a small town/rural area, is highly valued. Recreational opportunities are excellent and diverse. Residential perceptions of the aesthetic setting of the area are consistently high. The area is "picturesque."

There is widespread residential interest in improving the quality of air and water throughout the County. Residents, aware of the success of recent efforts to reduce industrial air and water pollution, perceive the present quality of their air and water to be "better than it was, but not as good as it can be."

Generally Clallam County is regarded favorably as a "place to live" by its residents. The basic rural atmosphere of the County, coupled with its scenic and recreational aspects, has contributed to a modest, but steady, population growth rate.

Due to the restricted size of the reservation owned by the Lower Elwha Tribal Community, population density is a problem. Some tribal members own land adjacent to the reservation, and others live in Port Angeles. Current data on sex and age distribution is unavailable.

During 1978, the last year from which work force and unemployment data were available from Federal sources, the work force on or adjacent to the Lower Elwha Tribal Community Reservation was 201. This figure includes Native Americans not enrolled in the tribe. There were 109 unemployed workers. The unemployment rate was 54 percent (BIA 1979). Full-time employment for workers is dependent to a large extent, on jobs in the wood products industries in Port Angeles. About 24 tribal people are employed at the tribal Fish Hatchery (SRI 1978). Forestry and fishing offer employment to others. Fishing also represents a source of supplementary income. Some 100 members of the tribe are active fishermen whose annual catch is valued at $130,000 (SRI 1978).

Tribal council members are concerned about the welfare of their constituents. One example of this is the tribal leaders work in effecting the establishment of the reservation in 1968. Another is the past and continuing effort with BIA agency staff to obtain improvements in educational, employment, and economic opportunties for tribal members. The Tribal council has approved plans to expand the tribal fish enterprise with a $500,000 program involving chum and Coho salmon, and steelhead trout cultivation (SRI 1978).

Concern over tribal welfare also has led the council to activity support legal research and litigation concerning Indian water rights in cooperation with other tribal groups in the State. At issue for the Lower Elwha Tribal Community is water in the Elwha River. At the present time about 65 million gallons per day are pumped from the river for industrial use. The council maintains that this infringes upon their legal rights over water in the river.

Due to the overall size of the Makah Reservation, population density is relatively low. In the Neah Bay community, however, population density is quite high. The town of Neah Bay covers approximately 150 acres. Another 1,300 acres, bordering the town on the east, also is used for community facilities. Most of the population of the Makah Reservation lives within the borders of this 1600 acre area. The acreage also contains governmental installations, business, and community buildings (Makah Comprehensive Plan 1972).

The population of the Makah Reservation has increased from about 700 in 1970 to approximately 1025 currently (BIA 1979). No data are available on age or sex distribution.

The Makah labor force consisted of 320 persons in 1978. Unemployment was reported to be 62 percent (BIA 1979). Most of the employment, for tribal workers, was in the categories of forestry, trade, and government (Makah Comprehensive Plan 1972). Fishing supplemented income for about 650 tribal members, with an annual catch valued at $780,000 in 1978 (SRI).

Traditionally tribal leaders have been concerned about Makah welfare. The council, in the early 1960's initiated litigation to clarify fishing rights for tribal members. Federal courts ruled in favor of the Makah claim to restrict non-tribal use of Makah fishing waters. Council members oversee the operations of a tribal development corporation and a housing authority. A tribal community cultural center, museum, and a $15 million fish hatchery are in various stages of construction or development (SRI 1978).

In general, the quality of life for the members of the Makah and Lower Elwha Tribal community is lower than for the non-Indian residents of Clallam County. Unemployment is high, per capita income generally is low, and opportunities are fewer for Indians than non-Indians. Due to Federal administrative regulations imposed by the Bureau of Indian Affairs and other agencies there are constraints on the extent to which local government can be fully responsive to the needs of reservation residents.

Efforts to improve the quality of life are underway. For example, the fish hatchery enterprises will help reduce tribal unemployment and raise reservation income. There are plans to improve housing conditions on both reservations. Efforts are underway to restore the water rights and fishing rights that were originally stipulated in treaties between the tribes and federal government. The increase of population on the two reservations indicates that many of the members of the Lower Elwha Tribal community and Makah Tribe prefer life on the reservation to life in a non-reservation environment. The reservation atmosphere provides them a sense of cultural identification, kinship, and community.

PIPELINE SYSTEM

CLIMATE

The climate along the proposed pipeline route is marine, characterized by mild winters, relatively cool summers, and an abundance of cloudiness and rainfall. Two major mountain ranges, the Olympics and Cascades, affect the climate by capturing much of the moisture carried from the Pacific by prevailing westerly winds. The mountains separate the moist, mild climate along the Pacific coast from the drier, more continental climate farther inland. Most of the rainfall occurs from October to May. Mean annual precipitation varies from about 15 inches near Sequim on the Olympic Peninsula to nearly 60 inches in the Cascade foothills, where the proposed route crosses the international boundary.

Along the proposed pipeline route average maximum temperatures in January range from 41° to 45°F with average minimum temperatures between 29° and 35°F. In July, average maximum temperatures range from 63° to 76°F, while average minimum temperatures range from 47° to 52°F.

Local wind patterns along the proposed pipeline route are strongly influenced by topographical features. Prevailing winds are westerly along the Strait of Juan de Fuca and south-southeasterly along the Cascade foothills. The strongest winds are observed along the westernmost portion where average speeds reach 14 miles per hour.

Severe weather, such as thunderstorms, high wind storms, hailstorms, and tornadoes, rarely occurs in western Washington.

AIR QUALITY

Air quality is considered good along most of the proposed pipeline route. Some limited data are available for the total suspended particulates, sulfur dioxide, and ozone. Average annual particulate concentrations for the year 1977 ranged from 34 ug/m3 at Port Townsend to 66 ug/m3 at Port Angeles (Washington State Department of Ecology 1978). A portion of Port Angeles is in a nonattainment area for particulates. Elsewhere, concentrations are within the standards. Rural areas would tend to have the lowest concentrations.

Sulphur dioxide levels exceeding state standards have been measured in Port Angeles. Elsewhere, sulfur dioxide concentrations are expected to be low, typical of rural areas. Ozone levels have been measured at Sequim. The highest ozone reading in 1977 was 0.05 parts per million. Ozone levels are expected to be typical of rural surroundings along the route.

NOISE

Noise along the rural segments of the proposed pipeline route generally is low. Noise levels increase around urban areas such as Port Angeles, Stanwood, Mount Vernon, and Bellingham, due to local and highway traffic, residential activities, and light commercial activity.

Noise sensitive receptors along the proposed pipeline route include the Dry Creek School (approximately 3 miles west of Port Angeles), residential areas of Port Angeles and rural and suburban homes where they occur.

Noise sensitive receptors at the site of the Fairmont pump station, pipeline mile 47, include a few scattered rural residences. The site proposed for the Burlington pump station at pipeline mile 105 would be located next to an existing pump station. Noise sensitive receptors include rural residential areas.

TOPOGRAPHY AND GEOLOGY

Topography

The proposed pipeline route in Washington State would cross portions of two physiographic subprovinces, the Olympic Mountains and Puget Lowlands, in the Pacific Border province (see Map Addendum).

Olympic Mountains Subprovince

The segment of the route from the onshore storage facilities (pipeline mile 0) to Snow Creek (pipeline mile 47), near Fairmont, is within the Olympic Mountains subprovince. Between pipeline miles 0 and 33 (near the Dungeness River), the terrain traversed by the proposed route consists of rolling hills and relatively flat glacial outwash plains dissected by numerous north-flowing streams in steep gullies and valleys. This segment has a gentle northward slope (2 to 5 percent) and lies between elevations of approximately 150 and 800 feet above mean sea level.

From the Dungeness River to Snow Creek (pipeline miles 33 to 47), the proposed route traverses the foothills of the Olympic Mountains. The proposed route elevation rises from 400 to 1,980 feet, and then descends to about 40 feet at pipeline mile 47. The slopes on the foothills along the route are generally between 10 and 30 percent except in a few localitites where slopes are as steep as 50 percent.

Puget Lowlands Subprovince

From Snow Creek (pipeline mile 47) to the Canadian border (pipeline mile 148), the proposed route would cross the Puget Lowlands subprovince. Over most of this route the terrain consists of rolling to flat lowlands below an elevation of 500 feet. On the overland crossings of Indian, Marrowstone, Whidbey, and Camano Islands, the elevation of the proposed route varies from sea level to over 300 feet. The proposed pipeline would cross four coastal bluffs--a 60-foot bluff at Nodule Point (pipeline mie 61), a 100-foot bluff near Bush Point (pipeline mile 64), a 180±-foot bluff north of Pratt's Bluff (pipeline mile 71), and a 100±-foot bluff 1 mile north of Lowell Point (pipeline mile 75). On the west side of the Cascade foothills, the route would cross the broad flat lowlands of the Stillaguamish and Skagit River Valleys. From pipeline miles 114 to 125 the proposed route would cross mountainous terrain between Chuckanut and Lookout Mountains, two foothills of the Cascade Range just southeast of Bellingham. Over this 11-mile segment, elevations range from about 300 to 950 feet. From Lookout Mountain to the Canadian border, the route would traverse the eastern margin of the Puget Lowlands subprovince, crossing rolling glacial terrain and portions of the Nooksack and Sumas River Valleys. Elevations along this segment are between 80 and 300 feet.

In this subprovince, a majority of the route would traverse nearly level to gentle slopes with gradients under 8 percent. Moderately steep to steep slopes (up to 20 percent) may occur at trans-sound crossings. Near the crossing on the east side of Whidbey Island the slope has a gradient of about 50 percent.

Physical Geology

The pipeline route would cross a region exhibiting a range of geologic conditions. Deposits range in age from Mesozoic to Recent (see table 2.1-10) and each subprovince exhibits different geology, structure, and tectonic history.

Olympic Mountains Subprovince

The Olympic Mountains are a structurally complex mountainous uplift. Along the northern flank of the Olympic Mountains (pipeline mile 0 to 40) the route would traverse areas of moderately steep, northward dipping Tertiary marine sediments (Tabor and Cady 1978). These sediments are overlain by Quaternary glacial drift (sand, gravel, silt, clay), generally less than 100 feet thick. From pipeline miles 40 to 46 the route would cross an area of Tertiary basaltic (volcanic) rocks. In this subprovince the route would cross several rivers with loose Quaternary and/or Recent alluvium beds (possibly with some organic matter).

Puget Lowlands Subprovince

The route would traverse areas of Quaternary sediments 100 to 300 feet thick in the Puget Lowlands subprovince (pipeline miles 47 to 148). These sediments are largely glacial, except in broad valleys of major drainages where thick alluvial deposits occur. Unconsolidated gravels, sands, silts, and some muds are expected on the shores of the proposed submarine crossings of Admiralty Inlet and Saratoga Passage. Small areas of Tertiary volcanic and/or sedimentary bedrock occur on the Quimper Peninsula and Marrowstone Island (pipeline miles 48 to 58). Mesozoic-early Tertiary sedimentary rock outcrops occur near Lookout and Chuckanut Mountains (about pipeline miles 114 to 125).

Geologic Hazards

Although several geologic hazards have been identified in the region of the proposed route only seismicity, slope instability, and to a lesser extent, outburst flooding would be considered serious threats to the integrity of the pipeline.

Seismicity

The proposed pipeline route would traverse Seismic Risk Zones 2 and 3 (see Map Addendum). Most of the proposed pipeline route is within Zone 3, in which major damage to man-made structures can occur. Between 1841 and 1976 about 14 significant earthquakes have had their epicenters within 10 miles of the proposed pipeline route.

Although there are several inferred surface or concealed faults (Tabor and Cady 1978, PSP&L 1974) in the Puget Sound area, three of which would be crossed by the pipeline, none have been directly related to the numerous instrument-located epicenters along the proposed route. Nearly all of these faults are geophysical irregularities (magnetic or gravity) that may represent non-tectonic features. While several surface fault ruptures have been identified along the proposed route, only the large fault system located south of Port Angeles which would be crossed by the pipeline, has shown apparent movement during the past 2-3 million years. It is considered potentially active.

Liquefaction

Liquefaction problems generally occur in areas of saturated, cohesionless, poorly compacted soils, such as floodplains and large river deltas. Areas crossed by the proposed pipeline with liquefaction potential include the Skagit and Stillaguamish Rivers, and possibly along some beaches at the proposed submarine crossings.

Slope Instability

For the most part, the proposed route is relatively free of areas of slope instability. Potential problem areas include the Olympic foothills near Blyn (pipeline mile 42) and Lookout-Chuckanut Mountains near Bellingham (pipeline mile 114 to 125). Also vulnerable are steep slopes adjacent to coastline and valley crossings, with (1) steep slopes accompanied by heavy precipitation; (2) repeated seismic disturbances upon loose rock material, unconsolidated sediments, and deeply weathered, fractured, or faulted rock; and (3) existing slide debris.

Outburst Flooding

Although potential flooding exists from burst dams at all major streams crossed by the proposed route, it is considered a hazard only where there are nearby dams or lakes upstream of the route. The Elwha River Reservoir, located 2 miles upstream of the river crossing (pipeline mile 12.5), is the only large reservoir near the proposed route. The Elwha Dam was recently classified "unsafe" by the U.S. Army Corps of Engineers (1978). As a result a site investigation and repair project has been authorized for the dam.

Mineral Resources

The pipeline route would cross no active mining operation or mineral deposit of known economic value, but would cross potential sources of aggregate (sand and gravel) along much of the route.

SOILS

General

A general discussion of soil classification and characteristics is provided in chapter 2. This soils discussion is limited to the land route distance of 142.5 miles. The remaining 5.5 miles is under water. There are at least 35 soil types traversed by the route; they vary according to the nature of the soil parent material, topography, and climate along the route.

Seasonal water tables, within 5 feet of the surface, occur on 42 percent of the route and would be susceptible to above average soil compaction during construction. About 20 percent of the soils occur within soil series designated as prime farmland by the Soil Conservation Service.

Olympic Mountains Subprovince

In this subprovince (pipeline miles 0 to 47) the soils generally are moderately deep to shallow loams, gravelly loams, and silty clay loams (USDA Soil Conservation Service 1951). Only a small portion of these soils are cultivated as they are low in fertility and productivity and difficult to clear. Approximately two-thirds of the proposed route in this subprovince crosses slopes with gradients between 5 and 15 percent, but about one-sixth have slopes moderately steep to steep. Water erosion potential ranges from low to high and is influenced by slope. Shrink-swell potential is low. Corrosion to steel is moderate to high. On nearly level to gently sloping lands, water tables within 12 inches of the surface are common. Topsoil suitability for revegetation varies from poor to fair.

Puget Lowland Subprovince

In this subprovince (pipeline miles 47 to 148) the soils are generally gravelly sandy and silty loams on the uplands; and silty or fine sandy loam, and loam with occasional clay in the lowlands (USDA 1947, 1953, 1958, 1960). Depth to the water table varies from a few inches to several feet. Thirty-five percent of the soils have seasonal water tables occurring with 5 feet of surface. Ninety-seven percent of the route in Snohomish County, 93 percent of the route in Skagit County, 57 percent of the route in Island County, and 30 percent of the route in Jefferson County would traverse soils subject to high water tables, according to soil survey reports (USDA 1947, 1953, 1958, 1960, 1975). Shrink-swell potential is low; steel corrosion potential is medium to high; water erosion potential ranges from low to high. About 40 percent of the soils along the route would have low susceptibility to water erosion in the absence of protective ground cover. Thirty-five percent would have medium susceptibility and 25 percent would have high susceptibility. Dominant soil types in the uplands are Alderwood, Hoypus, and Whidbey. Only portions of these soils are cultivated, as they are low in fertility and productivity and difficult to clear. In the lowlands, the highly fertile and productive Puget and Puyallup soils are dominant. Many of the lowland soils have a moderate compressibility, with possible deposits of peat and muck. Topsoil suitability for revegetation is poor to fair in the uplands and good in the lowlands.

AQUATIC RESOURCES

Physical Components

The surface water discussion addresses physical and chemical characteristics of major streams crossed by the proposed pipeline. Major streams are those requiring U.S. Army Corps of Engineers Section 10 permits, those requiring individual or general Section 404 permits under the discretionary authority of the Corps, and those with a 100-foot or greater high water width.

Surface Water Hydrology and Water Quality

The proposed pipeline route crosses numerous streams and rivers between Low Point and the Canadian border. The smaller unnamed streams typically have flows on tne order of a few cubic feet per second (cfs), while the largest river, the Skagit has an average flow of about 17,000 cfs. Names and locations of the eight largest streams are listed in table 8.4.2-34. Morse Creek and the Lyre, Elwha, and Dungeness Rivers drain northward from the Olympic Peninsula to the Strait of Juan de Fuca. The Skagit, Samish, and Nooksack Rivers drain westward from the Cascades into the Puget Sound Basin, while the Sumas River flows north into Canada.

TABLE 8.4.2-34 MAJOR STREAM CROSSINGS

River	Pipeline Mile	County
Lyre	1	Clallam
Elwha	12.5	Clallam
Morse Creek	22	Clallam
Dungeness	32.5	Clallam
Skagit	101	Skagit
Samish	105	Skagit
Nooksack	138.5	Whatcom
Sumas	141	Whatcom

During winter and spring, the primary source of water for the streams is direct runoff from precipitation. During summer and fall water is primarily supplied from aquifers and snowmelt. Flows typically peak during winter and again in late spring during maximum snowmelt. Low flows generally occur in September and October, whe many of the small streams may go dry. Discharge data for the eight major streams are shown in table 8.4.2-35.

Surface water quality in the project area generally is excellent and suitable for most uses. Concentrations of dissolved solids are usually less than 75 milligrams per liter (mg/l), and is considered "soft" (Pacific Northwest River Basins Commission 1970). Suspended solids are generally low, but show large and rapid fluctuations during floods with values ranging from less than a few mg/l to hundreds of mg/l. Table 8.4.2-36 provides a summary of selected water quality characteristics of the streams listed in table 8.4.2-34.

The Washington Department of Ecology has established 5 water quality classifications (AA, A, B, C, and Lake) for surface waters within the state (Washington Department of Ecology 1977a). Classifications of the 8 major streams crossed by the proposed pipeline route are given in table 8.4.2-36. The water quality criteria for Class AA and A surface water are shown in chapter 2. Generally, the water quality in these streams meets the state criteria. However, there have been measurements of dissolved oxygen below the criteria range in the Samish and Sumas Rivers. Acidity measurements below the criteria range have been recorded in the Elwha, Dungeness, and Skagit Rivers.

TABLE 8.4.2-35 DISCHARGE DATA FOR MAJOR STREAM CROSSINGS

River	Station Number	Discharge Data for Period of Record, cfs				Discharge Data for Most Current Water Year												Low Flow 10-Year Recurrence	
						Yearly Basis				Monthly Averages									
		Period of Record	Ave.	Min.	Max.	Water Year	Average	Min.	Max.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	7-Day	30-Day
Lyre	NO DATA																		
Elwha	12045500 Near Port Angeles, WA	1897-1901 1918-1977	1,510	10	41,600	1977	870	210	5,340	1,180	1,300	1,590	780	680	600	500	570	300	380
Morse Creek	12047300 Near Port Angeles, WA	1966-1976	130	5	3,160	1976	170	22	800	106	207	170	135	70	38	155	313		
Dungeness	12048000 Near Sequim, WA	1923-1930 1937-1977	390	68	6,820	1977	200	76	970	270	290	450	230	200	170	130	120	95	110
Skagit	12200500 Near Mount Vernon, WA	1940-1977	16,840	2,740	144,000	1977	11,860	3,680	52,800	15,540	13,010	14,550	9,310	9,670	7,330	7,000	10,200	5,100	5,800
Samish	12201500 Near Burlington, WA	1959-1971	247	23	1,170	1977	180	23	560	280	260	72	46	28	31	96	200	20	21
Nooksack	12210500 Near Deming, WA	1936-1957 1965-1977	3,390	500	43,200	1977	2,510	790	21,400	3,280	3,130	3,720	2,010	2,180	1,530	1,520	1,880	760	950
Sumas	12215100 Near Huntingdon, BC	1960-1968 1970-1977	120	1.1.	1,650	1977	84	14	800	100	64	63	32	24	33	50	80		

Source: TMC 1978

TABLE 8.4.2-36 WATER QUALITY CHARACTERISTICS OF MAJOR STREAM CROSSINGS

River	Station Number	Period of Record	State Classification	Temperature °C		Dissolved Oxygen mg O_2/liter		pH Standard Units		Conductivity micro mhos/cm		Dissolved Solids mg/liter		Suspended Solids mg/liter		Turbidity JTU	
				Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Lyre	NO DATA		AA														
Elwha	12045500 Near Port Angeles, WA	1959-1978	AA	8.1	2.6-15.5	11.7	9.6-14.1	7.4	6.4-8.1	81	10-112	52	30-68	9.2	1.0-94	5.8	1.0-70
Morse Creek	NO DATA		AA														
Dungeness	18A070 Near Sequim, WA	1959-1974	A	8.9	2.4-17.4	11.5	8.5-13.5	7.7	6.3-8.0	116	40-170	70	50-94	—	—	6.8	4.0-65
Skagit	12200500 Near Mount Vernon, WA	1959-1978	A	9.4	2.5-19.1	11.2	9.3-13.7	7.2	4.9-8.4	52	30-76	36	12-53	59	8.0-465	8.5	1.0-65
Samish	12201500 Near Burlington, WA	1959-1978	A	9.9	2.4-19.8	11.2	7.0-13.5	7.2	6.6-8.1	82	48-145	52	30-77	—	—	9.0	1.0-60
Nooksack	12211500 Near Lynden, WA	1977	AA	8.5	2.4-16.5	11.3	9.7-13.0	7.4	6.9-7.8	93	70-130	—	—	—	—	20.0	3.0-75
Sumas	12215100 Near Huntington, B.C.	1977	A	10.2	2.0-19.2	9.1	6.2-12.6	7.5	7.0-7.9	270	240-295	—	—	—	—	12.4	1.0-75

Source: TMC 1979

Ground Water Hydrology

Ground water along the northern edge of the Olympic Peninsula moves north toward the Strait of Juan de Fuca. Depth to the water table in this region generally is less than 100 feet (NTPC 1978). Aquifers contained in Quaternary sediments consisting of fine materials deposited by ancient rivers and glaciers may be encountered within 5 feet of the land surface in valley areas. Aquifers are recharged by precipitation and runoff, and discharged through both onshore and offshore springs. Water quality generally is good, and is used for domestic, agricultural, and livestock needs.

Ground water constitutes the only significant source of water on Whidbey and Camano Islands. The ground water table and semi-perched and perched aquifers occur in Pleistocene glacial deposits overlain by sediment. Thirty-two percent of drilled wells are less than 100 feet deep, 47 percent are between 100 and 200 feet deep, 18 percent are between 200 and 300 feet deep, and 3 percent are more than 300 feet deep (Anderson 1968). Precipitation is the only source of recharge. Most natural discharge (which greatly exceeds well withdrawal) is through springs along the sea cliffs (Anderson 1968). Ground water on these islands is termed "normal," with dissolved solids ranging from 100 to 300 mg/l, with some exceptions in Whidbey and Camano Islands. Wells along the shores of these islands are subject to sea-water encroachment (Anderson 1968).

Ground water along the route segment from Stanwood to the Canadian border exists in river and glacier deposits. Along the Skagit River and by Lake Whatcom water may be encountered at shallow depths. Further north in the Nooksack River Basin, major aquifers occur above and below glacial till in recessional and advance glacial outwash (Washington Department of Conservation 1960). Recharge is primarily through direct precipitation and, to a lesser extent, by seepage from surface drainage. Some artifical recharge occurs from irrigation waters. Although high concentrations of iron occur in some parts of the area, water quality is usually excellent (TMC 1979).

Biological Components

Description

General

Fishes would be a major concern during construction, operation, and abandonment of the proposed pipeline. Salmon and trout are emphasized because of (1) their economic and biologic importance; (2) their position at the top of the aquatic food web in most of the streams crossed by the pipeline; and (3) their well-documented sensitivity to environmental stresses.

According to the list published by the U.S. Fish and Wildlife Service, there are no known endangered or threatened fish species along the proposed corridor. This list was published in accordance with Public Law 93-205, The Endangered Species Act of 1973.

The invertebrate life in streams crossed by the proposed pipeline corridor has not been studied in detail but is expected to include mollusks (snails and clams), arthropods (aquatic insects, crustaceans, mites), flatworms, roundworms, segmented

TABLE 8.4.2-38 PIPELINE CROSSING LOCATIONS ON SELECTED WASHINGTON STREAMS AND AFFECTED HABITATS, HATCHERIES, AND FISHERIES

Main Stream	Approximate Pipeline Mile 1/	Miles of Spawning Habitat 2/	Significant Spawning Habitat 3/	River Mile Crossing Location 4/	Name and Location of Hatchery Facility 5/	Indian Fishery 6/	Remarks
Susie Creek	0.25	— 7/	—	0.5			Estimated spawning to RM 1 to 2.
Lyre River	1	2.7	—	1			
Nelson Creek	1.5	—	—	1.5			Estimated spawning to RM 2.
Field Creek	3	—	—	2.5			Impassable falls near mouth.
Whiskey Creek	4	—	—	1.8			Blockage in mouth vicinity.
Unnamed Creek No. 1	4.25	—	—	1.6			"
Unnamed Creek No. 2	6	—	—	3.5			"
Unnamed Creek No. 3	6.75	—	—	0.3			"
Salt Creek	9	6.4	—	5.5			
Elwha River	12.5	4.9	0-4.0	2.5	A fish rearing facility completed in 1975 at RM 3.0	Lower Elwha Tribe fishery on lower mile of river	
Dry Creek	15	—	—	2.7			Much of watershed dry during summer-early fall.
Tumwater Creek	19	—	—	2			Extensive culverted areas.
Valley Creek	19.5	—	—	1.7			Extensive culverted areas
Ennis Creek	21	2	—	1.5			Culvert problems.
Lees Creek	21.5	—	—	1.25			Limited use due to size and summer flows.
Morse Creek	22	3.8	—	2.25			
Bagley Creek	23.5	0.1	—	2.75			
Siebert Creek	25	8	—	4			Culverts form partial barriers at times.
McDonald Creek	26.5	5.2	—	4.75			Irrigation water diverted at RM 3.1.
Matriotti Creek	29	—	—	6			
Bear Creek	32	—	—	1			
Dungeness River	32.5	16.5	0-16	7	Dungeness Salmon Hatchery at RM 10.5 with a satellite station at Hurd Creek (RM 2.9)	Lower Elwha Tribe fishery primarily below the crossing	

TABLE 8.4.2-38 (Continued)

Main Stream	Approximate Pipeline Mile 1/	Miles of Spawning Habitat 2/	Significant Spawning Habitat 3/	River Mile Crossing Location 4/	Name and Location of Hatchery Facility 5/	Indian Fishery 6/	Remarks
Dean Creek	40	0.4	---	0.75			
Jimmycomelately Creek	40.5	1.9	---	0.5			
Salmon Creek	46	2	---	0.5			
Snow Creek	47	4.9	---	0.5			
Chimacum Creek	53	14	---	3			Coho spawn above RM 9.
East Chimacum Creek	53.5	---	---	0.25			Salmon production is very limited.
Davis Slough (brackish)	84	---	---				
West Pass (brackish)	84.5	---	---				
Stillaguamish River 8/ (via West Pass)		17.75	2-16	1.5	State trout hatchery and trout rearing facilities are located upstream at Cicero, Whitehorse, and Fortson	Stilliguamish Tribe fishery upstream of crossing	
Carpenter Creek	91	---	---	0.25			Utilized by salmon
Skagit River	101	96.6	15-84	8.5	State salmon enhancement facilities include the Skagit Salmon Hatchery at Marblemount (RM 78), salmon spawning beaches on the Upper Baker River and rearing ponds adjacent to the Skagit River near Newhalem (RM 94). State trout enhancement facilities include rearing ponds in Barnaby-Harrison Sloughs (RM 71).	Skagit System Cooperative (three Indian tribes) fishery includes waters above and below crossing	
Samish River	105	31	5-25	8		The Swinomish Tribe fishery on the lower river below the crossing	
Friday River	115	9.4	---	8.75	State salmon hatchery at 10.5	Only stream crossed with a fisheries enhancement facility located downstream.	

TABLE 8.4.2-38 (Continued)

Main Stream	Approximate Pipeline Mile 1/	Miles of Spawning Habitat 2/	Significant Spawning Habitat 3/	River Mile Crossing Location 4/	Name and Location of Hatchery Facility 5/	Indian Fishery 6/	Remarks
Whatcom Creek	126	2.25	---	2.7	Bellingham trout hatchery at about RM 3 and Lake Whatcom trout hatchery on Lake Whatcom.		Lower reaches used by salmon and steelhead
Squalicum Creek	129	9.75	---	5			
Deer Creek	130	---	---	7.5			
Ten Mile Creek	133	---	---	10.5			
Nooksack River	138.5	65	1-35	25	Salmon enhancement programs include the state hatchery on Kendal Creek RM 46) and the Lummi Tribe salmon hatchery on the North Fork of the Nooksack	The Nooksack and Lummi Tribe fishery on the lower river below the crossing.	
Sumas River	139.5-144.5	Upper 13	---	5 crossings from RM 4.5 to 14			
Breckenridge Creek	140	---	---	---			
Kinney Creek	142	---	---	---			

Sources: PNRBC 1970; Williams et al 1975; Phinney and Bucknell, 1975

1/ Approximate pipeline mile where crossing would occur.

2/ Approximate number of miles of spawning and rearing habitat for anadromous and resident salmon and trout on stream mainstem. Includes areas both upstream and downstream from proposed pipeline crossing.

3/ Location of significant spawning areas for anadromous and resident salmon and trout by river mile. Note: The source did not cover the Olympic Peninsula west of the Elwha Basin.

4/ Approximate location of proposed pipeline crossing by river mile from the mouth, except for the Sumas River which is from the U.S./Canadian border.

5/ Name and location of hatchery. River mile number is that of the main stream where fish released from the hatchery would enter.

6/ Name and location of Indian river fishery. Additional Indian fisheries currently in litigation. Note: For additional information see figure 2.1.2.6-1.

7/ --- line means no specific data were located in the sources referenced.

8/ Note: The Stillaguamish River is not directly crossed. The proposed pipeline route crosses West Pass, a slough into which the Stillaguamish flows.

worms, and possibly freshwater sponges. These are "food chain" organisms which, along with terrestrial insects, serve as a primary food source for salmon, trout, and nonmigratory fishes. Many aquatic invertebrates eat plants, other animals, or both. Others feed on organic matter present within bottom sediments or drifting with the current. Their distribution is influenced by streambed and flow conditions; somewhat different animal life exists in riffle than in pool areas of streams. Invertebrate abundance is influenced by a wide range of physical environmental factors such as temperature, water quality, substrate, flow, and by biological factors such as predation and competition.

The pipeline corridor would cross 43 streams known to support various salmon species (table 8.4.2-37). Small creeks, sloughs, and tributaries along the proposed pipeline corridor support small numbers of resident and migratory salmon, but are very important as reproduction sites.

Small creeks would be crossed in the Island County portion of the proposed pipeline corridor. The creek segments adjacent to or crossed by the pipeline have no known salmon use (Williams et al. 1975). However, some of these creeks may have resident trout populations.

Information on spawning habitat, hatcheries, and Indian fisheries is presented in table 8.4.2-37. Life history information is presented in figures 8.4.2-6 thru 9.

TABLE 8.4.2-37 KNOWN SALMONID OCCURRENCE AND FISHERY VALUE

Stream	Approximate 1/ Pipeline Mile	Fishery Value 2/	Chinook	Coho	Pink	Chum	Sockeye	Steelhead	Other Searun Salmonids	Resident Trout
Prime Route										
Susie Creek	0.25	H		X		X		X	X	X
Lyre River	1	H	X	X	X	X		X	X	X
Nelson River	1.5	H		X		X		X	X	X
Field Creek	3	H		X				X	X	X
Whiskey Creek	4	H		X				X	X	X
Unnamed Creek No. 1	4.25	H		X				X	X	X
Unnamed Creek No. 2	6	H		X				X	X	X
Unnamed Creek No. 3	6.75	H		X				X	X	X
Salt Creek	9	H	S	X		X		X	X	X
Elwha River	12.5	H	X	X	X	X		X	X	X
Dry Creek	15	H		X						
Tumwater Creek	19	H	*3/			*		X	X	X
Valley Creek	19.5	H	*			*		X	X	X
Ennis Creek	21	H	*			*		X	X	X
Lees Creek	21.5	H	*			*		X	X	X
Morse Creek	22	H	X	X	X	X		X	X	X
Bagley Creek	23.5	H		*		*		X	X	X
Siebert Creek	25	H		X		*		X	X	X
McDonald Creek	26.5	H	*	X	X	X		X	X	X
Matriotti Creek	29	H		*		*		X	X	X
Bear Creek	32	H		X		*		X	X	X
Dungeness River	32.5	H	X	X	X	X		X	X	X
Dean Creek	40	H		*		*		X	X	X
Jimmycomelately Creek	40.5	H		X		X		X	X	X
Salmon Creek	46	H		X		X		X	X	X
Snow Creek	47	H		X		X		X	X	X
Chimacum Creek	53	H		X		X		X	X	X
East Chimacum Creek	53.5	H		X		X		X	X	X
Davis Slough (brackish)	84	H								X
West Pass (brackish)	84.5	H	X	X	X	X		X	X	X
Stillaguamish River 3/ (via West Pass) (slough)										
Carpenter Creek	91	H				*4/		X	X	X
Skagit River	101	H	X	X	X	X	X	X	X	X
Samish River	105	H	X	X		X		X	X	X
Friday Creek	115	H	X	X		X		X	X	X
Whatcom Creek	126	H		X		X		X	X	X
Squalicum Creek	129	H		X		X		X	X	X
Deer Creek	130	H		X		X		X	X	X
Ten Mile Creek	133	H		X		X		X	X	X
Nooksack River	138.5	H	X	X	X	X	X	X	X	X
Sumas River (several crossings)	139.5-144.5	H								X
Breckenridge Creek	140	H						X	X	X
Kinney Creek	142	H							X	X

TABLE 8.4.2-37 (Continued)

Sources: Phinney and Bucknell 1975; Williams et al. 1975; PNRBC 1970; TMC 1979

1/ Approximate pipeline mile where crossing would occur.

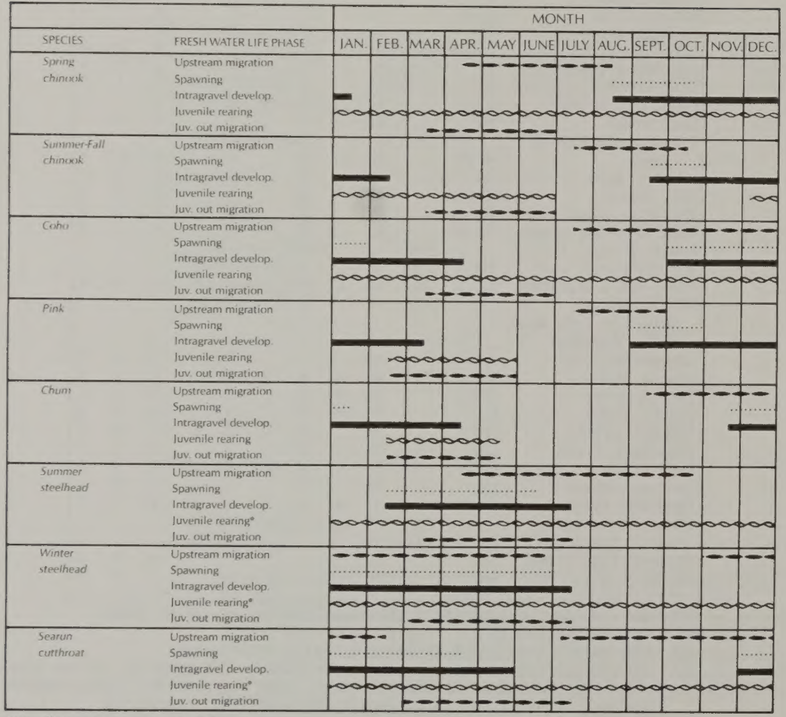
2/ Overall value of the fishery, including all species values based upon the following considerations: fish population, size, habitat, quality, angler preference, access, availability, commercial importance, stocking levels, local and regional importance, etc. H = High

3/ Note: The Stillaguamish River is not crossed directly. The proposed pipeline route crosses West Pass (a slough into which the Stillagumish River flows).

4/ * - Possible occurrence

FRESH WATER LIFE HISTORY PHASES

SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE STILLAGUAMISH BASIN



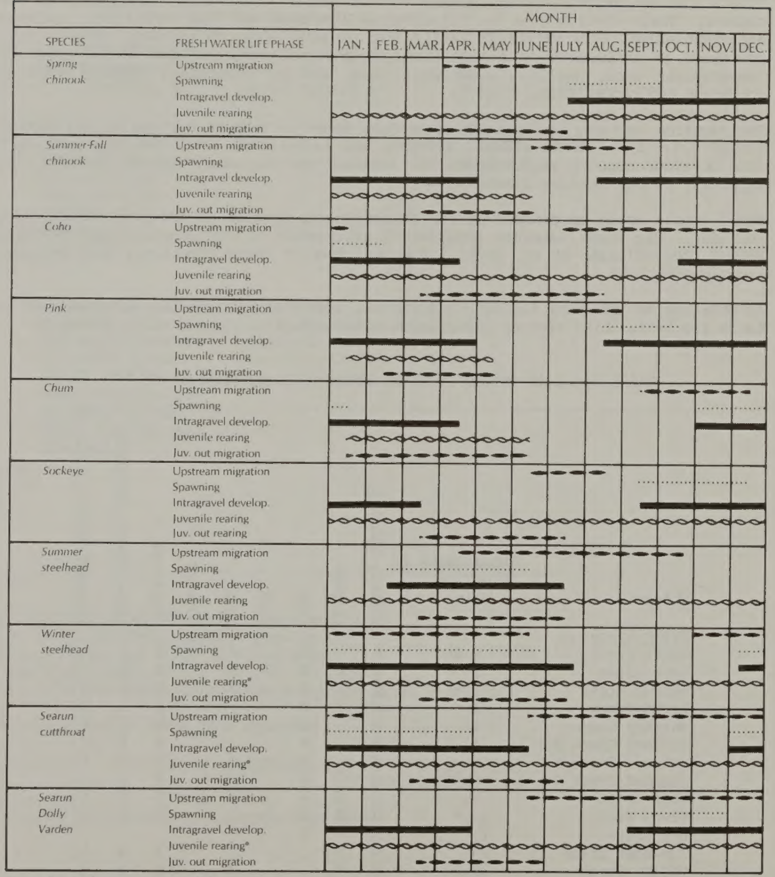
*Normally extends over a two-year period

Source: Pacific Northwest River Basins Commission 1970 and Dames & Moore 1978

Figure 8.4.2-6

FRESH WATER LIFE HISTORY PHASES

SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE SKAGIT BASIN



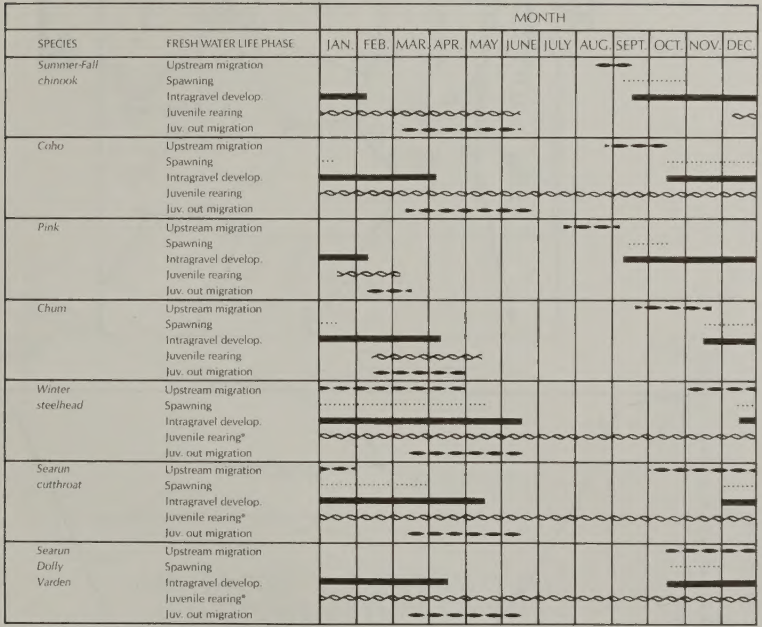
*Normally extends over a two-year period

Figure 8.4.2-7

Source: Pacific Northwest River Basins Commission 1970 and Dames & Moore 1978

FRESH WATER LIFE HISTORY PHASES

SALMON AND SEARUN TROUT FRESH WATER LIFE PHASES IN THE SAMISH BASIN



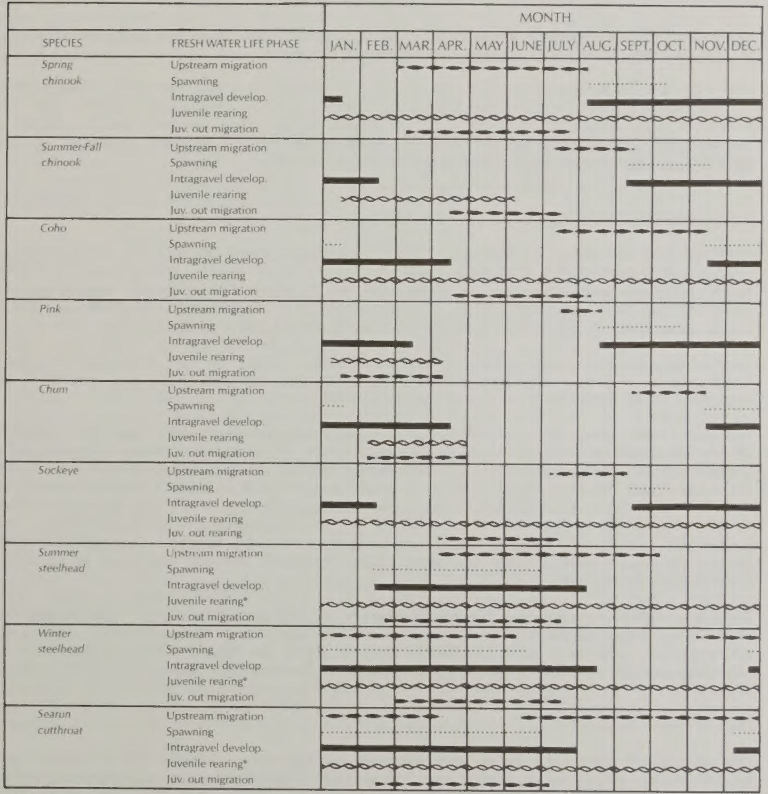
*Normally extends over a two-year period

Source: Pacific Northwest River Basins Commission 1970 and Dames & Moore 1978

Figure 8.4.2-8

FRESH WATER LIFE HISTORY PHASES

FRESH WATER LIFE PHASES OF SALMONIDS IN NOOKSACK-SUMAS BASIN



*Normally extends over a two-year period

Source: Pacific Northwest River Basins Commission 1970 and Dames & Moore 1978

Figure 8.4.2-9

Physical Components

This section describes physical marine conditions at the proposed pipeline crossings of the Oak Bay, Admiralty Inlet, and Saratoga Passage.

The Oak Bay crossing from the mainland to Indian and Marrowstone Islands would be very short and in shallow (about 15 feet) water. Admiralty Inlet, the main entrance into Puget Sound, is 3.25 nautical miles wide between Nodule Point on Marrowstone Island and Bush Point on Whidbey Island. Saratoga Passage is 2.25 nautical miles wide between Whidbey and Camano Islands.

Oceanographic Conditions

Peak surface currents in Admiralty Inlet near Bush Point exceeded 4 knots (Collias 1955). The components included tidal currents, wind drift, and estuarine circulation. Tidal charts show maximum flood and ebb flows at the proposed Admiralty Inlet crossing to be 3 and 3.5 knots, respectively (U.S. Department of Commerce 1973). Tidal ranges are expected to be 5.6 feet for the mean and 8.8 feet daily.

At the Saratoga Passage crossing the mean tidal range is 7.6 feet and the daily range is 11.3 feet. Maximum currents on both the ebb and flood are 0.5 knot and variable (U.S. Department of Commerce 1978, 1979).

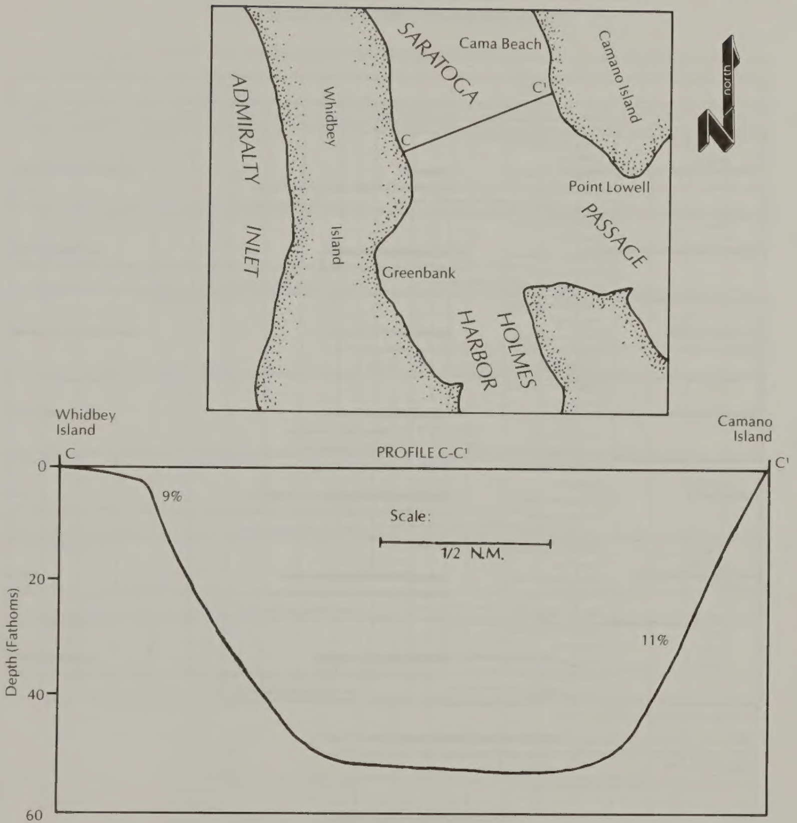
Several track lines of ocean floor and sub-bottom profiles were run near the site of the proposed Admiralty Inlet crossing as part of an earlier study (Oceanographic Commission of Washington 1975). Bathymetry (ocean floor profiles) for the Nodule Point to Bush Point crossing is presented in figure 8.4.2-10. Depths exceed 400 feet in the central channel. The channel axis is close to the Whidbey Island shore, which is reflected in slopes of up to 15 percent near Bush Point. The bottom is relatively smooth, with irregularities rarely greater than 1 foot. The bottom is predominantly sand and gravel with probable bedrock outcrops sporadically distributed along the route.

Figure 8.4.2-11, shows the basic bathymetry of Saratoga Passage. The slopes are less steep than those at the Admiralty Inlet crossing. The relatively low tidal currents in this area are likely to be reflected in finer bottom sediments. No exposed bedrock has been identified here and gravel and mixed-fine substrate is expected.

Marine Water Quality

The waters of Admiralty Inlet and Saratoga Passage are composed of a deeper, more saline ocean water and a relatively fresh upper layer, similar to the entire Puget Sound-Strait of Juan de Fuca system. Of these two inlets the flushing capacity is much lower in Saratoga Passage because of restricted tidal flow, about 40 days (OIW 1977).

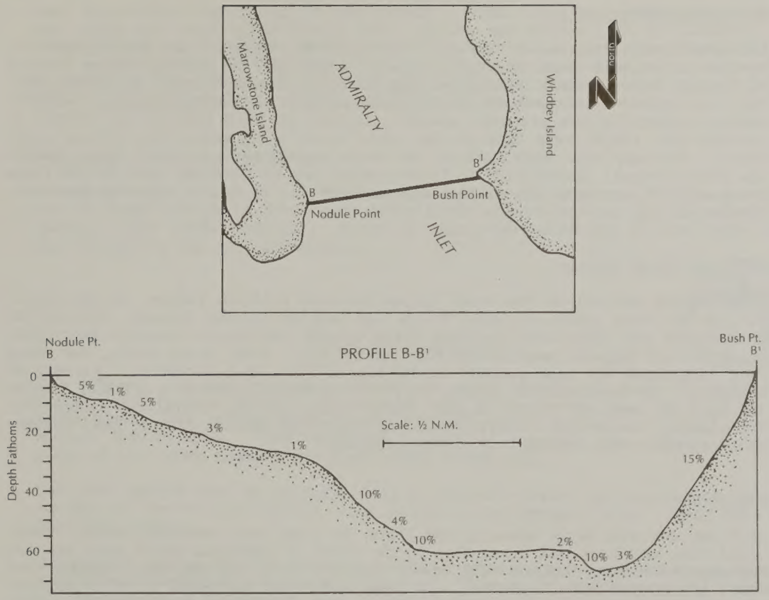
Saratoga Passage is strongly influenced by the Skagit River, exhibiting lower salinity than the Strait of Juan de Fuca or Admiralty Inlet. Admiralty Inlet is



BATHYMETRY FOR SARATOGA PASSAGE AT PROPOSED PIPELINE CROSSING

Figure 8.4.2-10

Source: NOAA 1978



BATHYMETRY FOR ADMIRALTY INLET
AT PROPOSED PIPELINE CROSSING

Figure 8.4.2-11

Source: NOAA 1978

designated Class AA and Saratoga Passage is Class A (Washington Department of Ecology 1977a). Available data indicate that dissolved oxygen in Admiralty Inlet may occasionally fall below the Class AA criterion of 7.09 mg/l, and that temperature may exceed the 53°F criterion beyond which no man-induced increases are permitted (EPA 1979). Saratoga Passage data indicate that temperature, dissolved oxygen, and acidity have been measured outside the ranges for Class A (EPA).

Biological Component

The Map Addendum illustrates the distribution of marine mammals, birds, and important commercial and sport species of fish, including salmon and bottom fish. The seven areas are discussed below are of great biological importance and are likely to be impacted by the proposed project.

Sequim Bay

The Department of Ecology considers this to be a very important area--only three areas out of a total of 36 are listed higher in its November 1977 publication. Sequim Bay is a critical habitat for Pacific herring and capelin. Herring spawn along both sides of the bay. Salmon and cutthroat are regularly caught here and Pacific oysters are grown on tidal flats in the south bay. Subtidal and intertidal clams are abundant, and Goodwin and Shaul (1978) list major geoduck and hard shell clam (butter, littleneck, and horse) beds in the bay. Sequim Bay is a critical habitat area for the mallard and pintail ducks and is listed as an important habitat for the western grebe. Sequim Bay and Dungeness Spit and Bay are important feeding areas in all seasons, particularly for brant, rhinoceros auklets and other waterfowl. Canada geese may nest in these areas. Sand flats, large marshes and extensive eelgrass beds are all found within Sequim Bay.

Discovery Bay

Discovery Bay supports a diverse assortment of habitats, including tidal flats, salt marsh, eelgrass beds, gravel, sand and mud substrates. Critical habitat was designated for Pacific herring by the Department of Ecology (1977). The bay is important to numerous fish species including salmon, cutthroat, and steelhead. Goodwin (1978) and Goodwin and Shaul (1978) recorded major hardshell and geoduck clam beds in the bay. Four species of birds have important habitat in the bay, including western grebe, rhinoceros auklet, great blue heron, and northern bald eagle (Department of Ecology 1977). The rhinoceros auklet colony is the largest south of Alaska. Osprey have a critical habitat here.

Protection Island/Dallas Bank

Protection Island is located about two miles from the entrance of Discovery Bay; Dallas Bank is just to the north of this small island. The island is a critical habitat for five species of birds: rhinoceros auklet, black oyster catcher, pigeon guillemot, glaucous winged gull, and pelagic cormorant. This serves as an important habitat for the harlequin duck. Because of its importance as a haul out area for harbor seals the eastern end of Protection Island has been designated a critical habitat (Department of Ecology 1977). The bank supports a significant kelp bed, a major hard shell clam bed (Goodwin 1978) and important fish stocks including salmon.

Admiralty Inlet/Hood Canal

Admiralty Inlet is the link between Hood Canal, Puget Sound and the Strait of Juan de Fuca. This area would serve as a gateway for spilled oil to enter Hood Canal and Puget Sound.

This discussion will be limited to Admiralty Inlet, the upper reaches of Hood Canal and the juncture of Admiralty Inlet, Puget Sound, and Possession Passage.

In the upper reaches of Admiralty Inlet Goodwin and Shaul (1978) list major hard-shell and geoduck clam beds. Significant crab populations also occur. The Department of Ecology (1977) lists critical habitats in upper Admiralty Inlet for the following species: Pacific halibut, surf smelt, Pacific herring, northern bald eagle, pigeon guillemot, and canvasback. For the following birds this area provides important habitat: Barrows goldeneye, bufflehead, white-winged scoter, surf scoter, surfbird, black turnstone, rhinoceros auklet, and old squaw (Department of Ecology 1977). River otters are found south of Port Townsend. Large numbers of bottom and migratory fish also occur here, as do major salt marshes, eelgrass beds, and kelp beds.

Moving to the south, Kinney Point off Marrowstone Island is a major hardshell clam bed with an estimated 3.4 million pounds of butter, little neck, and horse clams (Goodwin and Shaul 1978). Across the inlet two adjacent beds are found. Laguna Point north and south have a combined estimate of 8.4 million pounds of butter clams alone. These same researchers also list important hard shell clam beds off Tala Point, Hood Head, Salsbury Point and in Squamish Harbor and Mats Channel. Goodwin (1978) has also reported major geoduck beds in this region. The Port Gamble geoduck bed is estimated at 4.5 million clams, the fourth largest of all 51 geoduck beds Goodwin lists in Washington inland waters. Thornduck Bay also supports a major geoduck bed. Many species listed by the Department of Ecology (1977) as having important habitats in the upper Admiralty Inlet area also have important or even critical habitats to the south. These include: Barrows goldeneye, bufflehead, rhinocerous auklet, surf scoter, old squaw, and harlequin duck. Critical habitat is listed for whitewinged scoter, northern bald eagle, canvasback, river otter (Port Ludlow, Pt. Hannon, Squamish Harbor, Port Gamble, Salsbury Point to Lofall), harbor seal (Port Gamble), Pacific halibut (Salsbury Point to Lofall, Port Gamble, and area to north) and Pacific halibut.

Thornduck Bay is the site of a large marsh which supports a substantial number of beavers. Extensive eelgrass beds are found on both sides of Hood Canal from the entrance most of the way to Sea Beck and Dabob Bay. Marshes are numerous. No critical habitats are designated at the juncture of Admiralty Inlet, Puget Sound, and Possession Passage. However, a diversity of habitats and good water quality make this area important biologically.

West Shore Whidbey Island

For a detailed discussion of this area refer to "The Intertidal and Shallow Subtidal Benthos of the West Coast of Whidbey Island, Spring 1977 to Winter 1978" by Herbert H. Webber, NOAA Technical Memorandum ERL Mesa-37. The Department of Ecology does not list any critical habitats on the west portion of Whidbey Island. Valuable marine communities are present, however, as much of this side of the island is covered with either kelp beds in the rocky areas or eelgrass beds in the sandy areas. The kelp beds contribute to the large populations of bottom fish. Salmon are also abundant. Goodwin (1978) lists a major geoduck clam bed north of Partridge Point with an estimated 2.6 million clams. Only six of the 51 major geoduck beds are larger.

Smith and Minor Islands

Both islands are within the Smith Island National Wildlife Refuge, in the Strait of Juan de Fuca, south of Lopez Island and west of Whidbey Island. Substantial hard bottom and rocky areas surround these islands and support sizeable kelp beds. These in turn support large bottom fish populations. Sand, mixed coarse, and mixed fine substrates are also present around the islands, thus providing a variety of habitats. The Department of Ecology (1977) lists Minor Island as a critical habitat and haul-out area for harbor seals. Minor Island is also a critical habitat for the glaucous winged gull. Smith Island is a critical habitat for the black oystercatcher, rhinoceros auklet, and pigeon guillemot.

Skagit Bay

This bay contains large areas of mud flats, eelgrass beds, and salt marsh. Hard-shell clam beds have been identified by the Corps of Engineers (Final Environmental Statement Swinomish Channel Maintenance Dredging 1976) in the bay. Goodwin and Shaul (1978) list other hard shell clam beds in the west bay where it joins Saratoga Passage. These beds are not classified as major. However, there are major soft shell clam beds in Skagit Bay; Goodwin and Jones (1976) estimated 12.8 million pounds. Crabs are abundant, supporting a commercial fishery. Bottom fish are abundant throughout the bay as are pink, chum, chinook, coho and sockeye salmon. The Department of Ecology (1977) has listed the western part of the bay as a critical habitat for steelhead, American shad, and surf smelt. Pacific herring spawn extensively here. The mud flats and marsh along the eastern part of the bay provide important habitat for dunlin, long billed dowitcher, western sandpiper, and bald eagle (Department of Ecology 1977). Critical habitats are listed for whistling swan, snow goose, mallard, and American wigeon. River otters live in the Skagit River (NOAA Technical Memorandum), and the delta has an XXXX rating, the highest category given by the Department of Ecology.

Saratoga Passage

Many shellfish species are important here. Goodwin (1978) identifies a major geoduck clam bed at the southern extreme of the passage. Pacific oyster culture and spawning areas occur in Holmes Harbor and Penn Cove. Intertidal and subtidal hardshell clams are found along most of the shoreline and shrimp are very abundant over the southern two-thirds of the passage. Crabs are a very important species in the north bay which joins Skagit Bay. Salmon and bottom fish are abundant, and herring spawn in the Holmes Harbor area. Critical habitats have been identified for surf smelt, mallard and canvasback ducks, and northern bald eagles. For eight other bird species this is classified as an important habitat (Department of Ecology 1977). River otters occur in the Holmes Harbor area (NOAA Technical Memorandum).

Threatened and Endangered Species

Endangered marine mammals are discussed earlier in the chapter. Bald eagle sites can be found throughout the basin; these birds are terrestrial species which frequently visit marine habitats. Areas of bald eagle sightings in the south basin can be found in the wildlife section.

TERRESTRIAL VEGETATION

The proposed pipeline corridor crosses two major vegetation zones as defined by Franklin and Dyrness (1973). The western part of the route, from Low Point to the Elwha River, lies in the Sitka Spruce Zone and changes gradually eastward into the Western Hemlock Zone. The remaining segment of pipeline lies within a special class of this zone, known as the Puget Sound Forest area.

The Sitka Spruce Zone is generally only a few miles wide, and may be considered a variant of the Western Hemlock Zone (Franklin and Dyrness 1973). This zone was described earlier.

The Western Hemlock zone is the most extensive vegetation zone in western Washington and the most important for timber production. Climax, or stable, areas of this zone are characterized by western hemlock and western red cedar, while Douglas-fir is present as a subclimax species. Extensive logging and burning has resulted in large areas being dominated by stands of Douglas-fir, and secondly by western red cedar and red alder.

Throughout the Western Hemlock Zone, community species composition appears to be related to moisture gradient and slope exposure (Franklin and Dyrness 1973) as well as to past logging. Typical communities are listed in table 8.4.2-39.

The Puget Sound Forest area is a variation of the Western Hemlock zone. Different plant associations may occur such as as pine forests dominated by lodgepole pine, western white pine and ponderosa pine, white oak woodlands, and extensive prairies dominated by Idaho fescue grass (Franklin and Dyrness 1973). The presence of these communities reflects the different glacial history, climate, and soils of the area. Poorly drained sites with swamp and bog communities are abundant.

Vegetation along the proposed pipeline corridor is predominately forest (approximately 53 percent) and farmland (approximately 38 percent). Riparian habitat occurs in relatively narrow bands along streams, rivers, and floodplains. The proposed pipeline route has been divided into five sections to facilitate the following discussion of plant life. The proportions of land cover types for each section are estimated in table 8.4.2-40.

TABLE 8.4.2-39 TYPICAL COMMUNITIES OF WESTERN HEMLOCK ZONE

Moisture Conditions	Community Dominants
Dry	Douglas-fir/creambush oceanspray
Intermediate mesic	Western hemlock/small golden chinkapin Western hemlock/Pacific rhododendron/salal Western hemlock/Pacific rhododendron/ Oregon grape
Very moist	Western hemlock/swordfern Western hemlock/swordfern/Oregon oxalis
Wettest	Western hemlock/skunkcabbage

Source: Franklin and Dyrness 1973

TABLE 8.4.2-40 LAND COVER TYPE ALONG PROPOSED PIPELINE ROUTE 1/

Pipeline Miles	Corridor Section	Forest	Agricultural/ Grassland	Urban	Fresh Water Marshes	Salt Water Marshes	Fresh Water	Salt Water
	Total	53	38	2	1	2	1	4
0- 28	Low Point to Siebert Creek	60	34	5	1	-	1	-
28- 64	Sibert Creek to Bush Point	68	22	1	-	1	1	8
64- 84	Bush Point to Stanwood	50	33	3	1	2	-	11
84-131	Stanwood to Laurel	46	50	2	1	1	1	-
131-148	Laurel to Sumas	31	64	-	7	-	2	-

1/ Percent covers are rough estimates.

Olympic Foothills

Low Point to Siebert Creek (pipeline miles 0 to 28)

From Low Point to Siebert Creek the pipeline crosses the Sitka Spruce and Western Hemlock Zones, and the Puget Sound Forest Area. This section is predominatly second-growth mixed coniferous-deciduous forest of merchantable quality. Dominant species are western red cedar, Douglas-fir, and red alder (NTPC 1978). Shrub cover is low to moderate and species include salmonberry, salal, Oregon grape, creambush, oceanspray, currant, red elderberry, and red blueberry. Ground cover is low in dense forest conditions, and moderate to high in clearings; grasses, rushes, swordfern, bracken fern, and leafy plants are present.

Approximately 34 percent of the proposed corridor between Low Point and Siebert Creek crosses farmland, consisting mainly of pasture with species such as orchard grass (NTPC 1978).

No federally proposed threatened or endangered plant species are known to occur along this segment of the corridor (pers. comm. FWS 1979).

Siebert Creek to Bush Point (pipeline miles 28 to 64)

The proposed corridor crosses an area of dense forest cover. Stands are characteristically young, as most of this area has been logged within the last 150 years.

The shrub and ground cover layers are similar to those described for the previous section of the corridor. Common shrub species of the power line right-of-way (which parallels the proposed corridor between Port Angeles and Snow Creek) include Oregon grape, salal, rhododendron, salmonberry, and juneberry.

The remainder of the vegetative cover in this section is chiefly farmland (22 percent). Pastures along this segment have grasses such as orchard grass, bent grasses, and fescue. Shrubs such as salmonberry and Himalayan blackberry frequently grow in the pastures (NTPC 1978).

No federally proposed threatened or endangered plant species are known to occur along this segment of the corridor (pers. comm. FWS 1979).

Whidbey and Camano Islands

Bush Point to Stanwood (pipeline miles 64 to 84)

This portion of the proposed corridor crosses Whidbey and Camano Islands. Roughly half of this section is forested and commercial species include Douglas-fir, western hemlock and western red cedar. Agricultural lands occupy approximately 33 percent of this segment, with products including hay, wheat, oats, forage, and vegetables (Pacific Northwest River Basin Commission 1970).

No Federally proposed threatened or endangered plant species are known to occur along this segment of the corridor (pers. comm. FWS 1979).

Western Cascade Foothills

Stanwood to Laurel (pipeline miles 84 to 130.5)

This section of the corridor crosses nearly equal amounts of agricultural lands and forested area. The first 25 miles crosses the agriculture areas of the Skagit-Samish River Basin. The delta supports an immense salt marsh and 180 bird species are commonly found there (WNHP 1979).

The remaining 21.5 miles of this segment passes through the forest valley between Lookout Mountain and Chuckanut Mountain. At pipeline mile 126, the corridor passes near the northwest corner of Lake Whatcom. One plant species proposed for threatened status on a 1978 federal list (Ayensu & DeFilips 1978) occurs in the vicinity of Lake Whatcom (WNHP 1979). Since the corridor has not been surveyed, it is unknown whether this plant is found along the route.

Laurel to Sumas (pipeline miles 130.5 to 148)

The proposed corridor passes primarily through farmland. Between Laurel and Eversen, pastureland and berry farms are common (NTPC 1977). Between Eversen and Sumas the corridor crosses pasture and cropland (peas, sweet corn, and silage corn).

Forest lands in this area are primarily small woodlots consisting of second-growth mixed hardwoods and conifers.

Riparian habitat occurs within the proposed pipeline corridor near the crossing of the Nooksack and Sumas Rivers, their associated floodplains, and their principal tributaries. Common species here include red alder, willow, black cottonwood, and western paper birch.

As a result of clearing and subsequent regrowth along the existing pipeline right-of-way, weedy grassland, shrub, thicket, and forest edge vegetation are found. Species found in these areas include bromes, fescues, blue grasses, rushes, sedges, weedy and residual forbs, shrubs, and red alder.

No federally proposed threatened or endangered plant species are known to occur along this segment of the corridor (pers. comm. FWS 1979).

TERRESTRIAL WILDLIFE

The proposed pipeline corridor traverses the Olympic foothills and the western Cascade foothills of northwest Washington. Characteristics of selected terrestrial habitats and associated species in northwestern Washington are presented in table 8.4.2-41.

The predominant big game associated with these regions is the black-tailed deer. Elk and mountain lion also may occur at higher elevations. Black bear populations are substantial (NTPC 1978). Furbearers such as the marten, fisher, long- and short-tailed weasel, bobcat, and coyote prey on the small mammals and birds of the area. Common small mammals associated with forests are the Trowbridge and masked shrews, Townsend chipmunk, red-backed vole, shrew mole, Douglas squirrel, and showshoe hare.

TABLE 8.4.2-41 CHARACTERISTICS OF SELECTED TERRESTRIAL HABITAT TYPES IN NORTHWESTERN WASHINGTON

Type	Habitat Description	Characteristic Flora	Characteristic Birds and Mammals
Wetlands	Freshwater marsh and swamps typified by standing water, poor drainage, and hydric vegetation. Marshes are dominated by herbaceous plants and swamps by woody plants. Organic accumulation and anaerobic soil conditions are common.	Marsh: Cattails, rushes, sedges, duckweed, sphagnum, skunk cabbage, pitcher plant, reed canary grass. Swamp: Red alder, western redcedar, black cottonwood, sweet gale, willows, Douglas spiraea, red-osier dogwood, skunk cabbage.	Great blue heron, American bittern, dabbling ducks, coot, common snipe, long-billed marsh wren, yellow throat, redwing, song sparrow; muskrat, beaver, river otter, raccoon, Oregon vole, Townsend mole, vagrant shrew, northern water shrew, shrew-mole, Townsend vole.
Croplands	Areas under cultivation, truck crops, orchards, berry farms.	Cultivated vegetation.	Red-tailed hawk, marsh hawk, ring-necked pheasant, killdeer, gulls, mourning dove, short-eared owl, crow, starling, savannah sparrow; blacktail deer, cottontail, coyote, raccoon, opossum, striped skunk, deer mouse, Townsend mole, Oregon vole.
Grassland/ Pasture	Herbaceous, low vegetation with no overstory.	Grasses, herbs.	Red-tailed hawk, marsh hawk, kestrel, killdeer, barn swallow, violet-green swallow, tree swallow, robin, starling, western meadowlark, Brewer's blackbird, brown-headed cowbird, savannah sparrow; cattle, horses, opossum, striped skunk, coyote, Oregon vole, deer mouse, vagrant shrew, Townsend vole, Townsend mole.
Riparian	Water edge habitat generally differentiated from surrounding areas by altered vegetation, often subject to periodic flooding.	Black cottonwood, red alder, cascara, willows, paper birch.	Great blue heron, screech owl, great horned owl, belted kingfisher, tree swallow, cliff swallow, violet-green swallow, willow flycatcher, crow, black-capped chickadee, Swainson's thrush, yellow warbler; beaver, river otter, raccoon, Townsend mole, vagrant shrew, shrew mole.

TABLE 8.4.2-41 CHARACTERISTICS OF SELECTED TERRESTRIAL HABITAT TYPES IN NORTHWESTERN WASHINGTON

Type	Habitat Description	Characteristic Flora	Characteristic Birds and Mammals
Early Sere Shrub	Early successional thicket. Shrub stage in forest lands	Blackberries, Oregon grape, vine maple, salal, Pacific rhododendron, snowberry, willows, sword fern, huckleberries, salmonberry, bitter cherry.	Sharp-shinned hawk, ruffed grouse, California quail, bushtit, Bewick°s wren, robin, orange-crowned warbler, rufous-sided towhee, Oregon junco, white-crowned sparrow, song sparrow; blacktail deer, cottontail, striped skunk, Townsend chipmunk, deer mouse, Oregon vole.
Second-Growth Mixed Forest	Young, vigorous forest with mixture of conifer and broadleaf tree species.	Douglas-fir, red alder, western redcedar, big-leaf maple, western hemlock, black cottonwood.	Band-tailed pigeon, great horned owl, pygmy owl, rufous hummingbird, flicker, downy woodpecker, western flycatcher, black-capped chickadee, chestnut-backed chickadee, red-breasted nuthatch, winter wren, robin, Swainson's thrush, golden-crowned kinglet, orange-crowned warbler, purple finch, pine siskin; blacktail deer, raccoon, northern flying squirrel, deer mouse, Trowbridge shrew, Townsend mole, Townsend chipmunk.

Source: NTPC 1977

Species such as the deer mouse, snowshoe hare, and black-tailed deer largely inhabit the fringes of the forests. These "edge" inhabitants feed on ground flora and buds and fruit of shrubs and young trees. Riparian habitats support muskrat, mink, river otter, beaver, raccoon, oppossum, weasel, and striped skunk.

Many songbirds use coniferous and mixed-forest habitats throughout the year. Characteristic species include the yellow warbler, common bushtit, purple finch, Swainson's thrush, and white-crowned sparrow (NTPC 1978). Woodland game birds include the band-tailed pigeon, ring-necked pheasant, ruffed grouse, and at slightly higher elevations, blue grouse. Wintering concentrations of bald eagles, waterfowl, and waterbirds occur in the area. The goshawk, Cooper's hawk, and the sharp-shinned hawk are all woodland birds of prey.

Rare, threatened, and endangered species in the State of Washington include the northern bald eagle, the peregrine falcon, and the trumpeter swan. Active bald eagle nests occur within the corridor on Marrowstone Island at Kinney Point and along the western shore of Kilisut Harbor. No other threatened and endangered species are known to inhabit the proposed corridor.

Olympic Foothills

Between Low Point and Siebert Creek the habitat is chiefly second-growth mixed coniferous-deciduous forest and farmlands. Characteristic species associated with these habitats are shown in table 8.4.2-41. Wildlife flourishes near the rivers and creeks in the corridor area. Habitat and species information for six locations along this section is shown in table 8.4.2-42. Critical areas identified near but not on this portion of the corridor include a bald eagle nest at Geeen Point and nests around Crescent Bay.

In the Elwha-Dungeness Basins the pipeline would pass through black-tailed deer, elk, and ring-necked pheasant habitat. The basin supports an annual average of 2,700 deer, with the area south of Sequim possessing the highest density (PNRBC 1970). The majority of elk reside within the Olympic National Park boundary except during severe weather. The annual elk-kill within the basins averages 40 to 50 animals (Pacific Northwest River Basin Commission 1970). The Elwha and Dungeness River areas provide high quality riparian habitat. Furbearers of the area include beaver, muskrat, mink, and river otter.

The most abundant upland game birds are the ruffled and blue grouse. The highest density of introduced game birds, including the ring-necked pheasant, the less common California quail, and gray- and red-legged partridge are on agricultural lands near Sequim, and would therefore be expected to occur in the pipeline corridor in this vicinity. Annual hunting figures for the Elwha-Dungeness area are 2,400 pheasants, 1,200 ruffed grouse, 250 blue grouse, 200 quail, and 2,000 band-tailed pigeons (Pacific Northwest River Basin Commission 1970).

High density waterfowl populations occur to the north of the pipeline corridor in the Dungeness National Wildlife Refuge. Limited freshwater marshes and lakes restrict the inland breeding areas, but waterfowl feed on grain available in agricultural areas of the corridor.

The proposed corridor between the Dungeness River and Marrowstone Island is predominately forest intermixed with some farmland. The wildlife supported by these habitats is similar to the Elwha-Dungeness section. The southern part of the Miller and Quimper Peninsulas has a relatively high abundance of deer and a medium to high density of pheasant (Pacific Northwest River Basin Commission 1970). The inland areas south of Sequim Bay and Port Discovery are designated as having a medium to high waterfowl density (PNRBC 1970) and are important waterfowl wintering areas. Port Discovery also provides year around habitat for bald eagles, south of Mill Point and near Woodmans (Coastal Zone Atlas of Washington, WA State Dept. of Ecology).

TABLE 8.4.2-42 SUMMARY OF WILDLIFE INFORMATION FOR SIX SAMPLE POINTS BETWEEN LOW POINT AND SIEBERT CREEK

Approximate Distance of Sample Points from Low Point (miles): Land Cover Type 1/:	0	4	8	10	14	20
	F/R	F/A	F/R/A	A/P	F	A/P
Cover						
Tree	H 2/	H	H	H	M	H
Shrub	H	L	M	L	L	M
Ground	L	H	L	M	L	H
Erosion Potential	L	L	L	M	H	M
Browse Availability	M	H	M	H	L	M
Nest Cavities	M	M	L	M	L	M
Den Sites	M	M	M	M	L	L
Open Water Availability	L	M	M	H	M	L
Wildlife Potential						
Small Mammals	H	M	H	H	M	M
Furbearers	M	M	L	L	L	L
Big Game	M	H	M	L	L	L
Song Birds	H	H	H	H	M	M
Waterfowl	M	M	L	M	M	L
Gallinaceous Birds	L	L	M	L	L	L
Raptors	M	M	M	M	L	M
Herpetofauna	M	M	M	M	M	L
Wildlife Habitat Quality	M	M	M	M	M	M

Source: NTPC 1978

1/ Land Cover Type:
A means agriculture,
F means forest,
P means powerline,
R means residential.

2/ Evaluation Categories:
H means high,
L means low,
M means moderate.

Marrowstone, Whidbey and Camano Islands

A resident population of bald eagles exists on Marrowstone Island. Active and successful nests occur along the western shore of Kilisut Harbor near the U.S. Naval Reserve and at Kinney Point (Grub 1975). Areas on Whidbey Island (Holmes Harbor) and Camano Island (Ustalady and Triangle Cove) also are considered bald eagle habitat (Washingon Dept. of Ecology 1979).

On Whidbey and Camano Islands the proposed corridor is predominately forest, farmland, and edge habitat. There is an abundance of deer and a medium to high pheasant and waterfowl density (PNRC 1970).

Western Cascade Foothills

The proposed corridor between Stanwood and Bayview is chiefly agricultural with some forest and salt wetland habitat. Major game species of agricultural and edge habitat include black-tailed deer, ring-necked pheasant, mourning doves, and California quail. There is a medium to high deer density around Mount Vernon, and low density around Burlington (PNRBC 1970). Pheasant density is medium to high throughout this section of the proposed corridor. The proposed corridor passes through prime waterfowl habitat in Snohomish and Skagit Counties.

The proposed pipeline corridor is routed along the eastern border of the Skagit Wildlife Recreation area, which provides habitat for nearly 200 species of songbirds, mink, deer, and game birds. The area constitutes extremely important habitat for migrating birds. Intertidal flats winter 20-35,000 snow geense annually (Washington Department of Game 1974). Birdwatchers frequent the area to see green heron, American bittern, whistling swan, snow geese, bald eagles, and numerous other species.

Northern bald eagles find suitable habitat along most of the Snohomish-Skagit coast (Washington Department of Ecology 1978a). Peregrine falcons have been observed along the eastern shore of Padilla Bay, 5 miles west of the proposed corridor (Grub 1975).

From Conway to the Canadian border near Sumas, the proposed corridor parallels existing corridors and crosses predominately forest and agricultural land. Grouse and rabbits which frequent edge habitats in this area are the most numerous upland game. South of Lynden, pheasant densities are medium to high (Pacific Northwest River Basin Commission 1970). Deer are abundant near the Canadian border.

The Nooksack River Basin provides a high quality waterfowl habitat. Fur animals including beaver, muskrat, mink, river otter, marten, weasel, skunk, raccoon, opossum, bobcat, lynx, red fox, and coyote also inhabit this area.

CULTURAL RESOURCES

Few cultural resource sites along the corridor proposed for the pipeline are currently known. Those which are known have, for the most part, been identified as the result of haphazard discoveries or highly localized surveys, some of which were made years ago. The cultural resources described below are the known resource base only. It is virtually certain that additional cultural resources will be discovered along the proposed pipeline right-of-way. The areas of potential impact from the proposed pipeline have not yet been systematically investigated with the objective of identifying cultural resources. Therefore, it is not possible to describe completely the existing cultural resource base which may be significantly affected by the proposed project.

Archaeological and Historical Resources

The areas traversed by the proposed pipeline contain evidence of the presence of human groups from earliest times to the present. Artifacts and bones indicate the presence of hunters of mastodon and other large mammals living in some areas as much as 10 to 12 thousand years ago. Later the archaeological record shows increasing regional specialization in food resource utilization and associated diversity in sites and in artifact assemblages. Sites related to shellfish procurement and salmon fishing are especially abundant in the areas of northwestern Washington which could be affected by the proposed project.

Historic sites are related to known Native American peoples and to the whole range of early Euro-American activities. These resources include explorers' trails and campsites, missions, fur trading posts, townsites, homesteads, logging camps, military posts, mines, railroads, railroad construction camps, and roads used by immigrants, merchants, and the military.

The cultural resource sites listed in table 8.4.2-43 are the officially recorded cultural resource base which could be affected by the proposed project. Not included are sites which might be known to local residents or specialized historians, sites mentioned in primary documentary literature, and sites of generally recognized historical value which have not been officially recorded and evaluated. In addition, there are numerous sites along the shorelines of the San Juan Islands. These sites, outside of the 2 mile wide study corridor, are not listed in the table. However, they are part of the cultural resource environment which would probably be affected if a leak occurred in the submarine pipeline. Submerged archaeological sites or ship wrecks may occur along the submarine pipeline route. None are currently known, but no underwater investigations have been carried out. In many cases the age and cultural affiliation of the archaeological sites listed in the table are not known. It is only after tests have been completed by qualified archaeologists that determinations of eligibility for the National Register of Historic Places and decisions about individual site significance can be made.

The latest edition of the National Register of Historic Places (February 6, 1979) was consulted, and those sites listed in the Register are indicated as such in table 8.4.2-43. A few of the sites have been developed to increase public awareness and understanding of the past. An assessment of their values and potential contributions to our knowlege of prehistory and history awaits further study.

TABLE 8.4.2-43 RECORDED CULTURAL RESOURCES WHICH COULD BE IMPACTED BY THE PIPELINE

County	Site Number	Site Name	National Register	Site type	Location By Mile Post
Clallam	45CA 10	-----	No	Campsite and shell midden	Onshore storage Facility Site
Clallam	45CA 11	-----	No	Campsite and shell midden	Onshore Storage Facility Site
Clallam	-----	Lincoln Park	No	Historic	20
Clallam	-----	Beaumont Cabin	No	Historic	20
Clallam	-----	Mt Angeles Cemetary	No	Historic	24
Clallam	-----	Fairview School House	No	Historic	28
Clallam	45CA 218	Manis Mastodon Site	Yes	Mastodon Kill site and butchering station-possible campsite	37
Jefferson	45JE 27	Port Hadlock Archaeological Site	No	Multicomponent prehistoric, historic	57
Jefferson	45JE 25	-----	No	Shell midden	57
Jefferson	45JE 24	-----	No	Shell midden	57
Jefferson	45JE 22	-----	No	Shell midden	58
Jefferson	45JE 23	-----	No	Shell midden	58
Island	45IS 28	-----	No	Potlach house	64
Island	45IS 89	-----	No	Shell midden	66
Island	45IS 17	-----	No	Shell midden	67
Island	45IS 16	-----	No	Fortified tench	70
Island	45IS 87	-----	No	Shell midden and burials	74
Island	45IS 95	-----	No	Shell midden	74
Island	45IS 44	-----	No	Shell midden	75
Island	45IS 1	Dugwalax	No	Shell midden and burials	79
Island	45IS 92		No	Shell mound	81
Island	45IS 11	-----	No	Shell midden	82
Island	-----	Camano Island Pioneer Cemetary	No	Historic cemetary	82
Island	45IS 12	-----	No	Burial	84
Island	-----	Pearson House	Yes	Historic home	85
Snohomish	45SN 1	-----	No	Shell midden	86
Snohomish	45SN 3	-----	No	Shell midden	88
Snohomish	45SN 2	-----	No	Shell midden	88
Skagit	45SK 49	-----	No	Shell midden	91
Skagit	45SK 56	-----	No	Shell mound	91
Skagit	45SK 113	Milltown	No	Town with historic structures	91
Skagit	45SK 50	-----	No	Shell mound	92
Skagit	45SK 59	-----	No	Shell midden	93
Skagit	45SK 63	-----	No	Shell midden	93
Skagit	45SK 115	Conway	No	Town with historic structures	94
Skagit	45SK 41	-----	No	Shell mound	96
Skagit	45SK 65	-----	No	Artifact locality	96
Skagit	45SK 39	-----	No	Shell midden	96
Skagit	45SK 79	-----	No	Shell midden	96
Skagit	45SK 101	-----	No	Fishing station	97
Skagit	45SK 40	-----	No	Shell mound	97
Skagit	45SK 64	-----	No	Shell midden	97
Skagit	45SK 112	Mount Vernon	No	Town with historic structures	100
Skagit	45SK 117	Avon	No	Town with historic structures	102
Skagit	45SK 90	-----	No	Campsite	103
Skagit	45SK 68	-----	No	Type not known	109

Sources: Washington Archaeological Research Center, Washington State University; Pullman, Washington
Washington Office of Archaeology and Historic Preservation; Olympia, Washington

Paleontological Resources

Fossils, like other cultural resources, are rare, fragile and irreplaceable, and nonrenewable resources for information about the past. The systematic recording of sites or rock formations known or presumed to contain fossils is just beginning. Table 8.4.2-44, which therefore must be incomplete, lists a few fossil-bearing localities identified along the route which are known to contain fossils and would be crossed by the proposed pipeline. The various sediments of later Pleistocene Age have potential for containing human skeletal remains and cultural material along with vertebrate fossil remains.

Fossil data for the entire route are unavailable, however, potential finds are expected in areas previously uninvestigated along the pipeline route.

TABLE 8.4.2-44 PALEONTOLOGICAL RESOURCES BY COUNTY ALONG THE PROPOSED PIPELINE CORRIDOR

County and State	Formation	Age	Item of Interest	Location
Clallam, WA	Twin River	Oligocene-Miocene	Marine sedimentary rocks	
	Twin River	Oligocene-Miocene	Fossils	Bluffs bordering Strait of Juan de Fuca immediately west of the West Twin River
	Peat Bog	Younger Quaternary	Mastodon and bison bones with human cultural material	Vicinity of Sequim
Whatcom, WA	Shales	Tertiary	Fossils	South of Bellingham
	Black shale	Tertiary	Fossils	Nooksack River on Highway 1

Sources: Washington Environmental Atlas 1975; Livingston 1959

VISUAL RESOURCES

The first 56 miles of pipeline would be located in the north shorelands of the Olympic Peninsula. Approximately 26 of these miles would run along an existing transmission line right-of-way. The terrain is low, rolling foothills, with conifer tree cover and intermittent open farm and pastureland. The route would cross Admiralty Inlet and traverse several islands including Indian, Marrowstone, Whidbey, and Camano. The islands are covered with coniferous forest, occasional pasture, and developed land, bordered by beaches and bluffs.

Lacking specific information concerning marine crossing points on the bluffs, it must be assumed the pipeline would descend from Marrowstone Island approximately 60 feet through the bluff to the shore, from where it would cross beneath Admiralty Inlet. It would then ascend the 100-foot bluff near Bush Point to Whidbey Island. Further north the pipeline would descend the 180-foot bluff on the east side of Whidbey Island, cross Saratoga passage, and ascend the 100-foot bluff near the small community of Saratoga Shores.

At Stanwood the proposed pipeline corridor would turn north and follow Highway 530 to Conway, where it would join the existing TMC pipeline right-of-way. It would then cross approximately 30 miles of flat to rolling coastal terrain. The route would pass through a mountainous area near Samish Lake to the west of Lookout Mountain. The remainder of the corridor would traverse flat to rolling terrain with intermittent forest cover, agricultural pasture, and cropland.

The visual sensitivity of the pipeline right-of-way is a function of its exposure to views from public areas. Portions of the pipeline right-of-way visible from travel routes (highways and railroads), recreational sites, and urbanized areas would have moderate to high potential for visual sensitivity. Sparsely populated areas such as extensive agricultural, tree farm and forest management, or ranching and range management areas would intrinsically have significant potential for visual impact during the short term. From pipeline miles 94 to 148 the corridor would be located within TMC's existing right-of-way. Anderson Lake State Park, Camano Island State Park, and Samish Lake are located near the 2-mile pipeline corridor.

The proposed route would pass near numerous urban fringe areas, rural towns, and scattered single family residential dwellings.

LAND USE

This section discusses general categories of land use and zoning in the vicinity of the pipeline. Specific land uses such as recreation, mining, and transportation are discussed in other sections. Lands with special management concerns including Native American areas, natural and scientific areas, and wilderness areas are discussed here. The final component of this section addresses land-use plans and zoning within the proposed pipeline corridor.

Forests (53 percent), and agriculture and grassland (38 percent), are the most predominant land uses found along the route. Other significant land use is residential and urban fringe (2 percent), wetlands (3 percent), and water (4 percent). General land use along the proposed route is listed in table 8.4.2-45.

TABLE 8.4.2-45 WASHINGTON - LAND USE BY MILES OF PROPOSED PIPELINE 2/

Area	Mileage all Uses	Urban	Agriculture/ Grassland	Forest/ Woodland	Other 1/
Olympic Peninsula (Clallam and Jefferson counties)	62	1	16	42	4
Island County	23	1	7	11	4
East Puget Sound (Snohomish, Skagit, and Whatcom counties)	63	1	33	25	4
Total 2/	148	3	56	78	12

1/ Includes water and watershed areas

2/ Figures estimated from Dames and Moore Land Type by percent cover

Urban

The proposed pipeline route passes near numerous residential developments, urban fringe areas, and isolated single-family dwellings. Several small communities and cities are located in the vicinity of the proposed route. Rural residential land use occurs commonly in agricultural and forested areas. Cities, towns, and rural centers near the pipeline corridor and their populations are listed in table 8.4.2-46.

TABLE 8.4.2-46 CITIES, TOWNS, RURAL CENTERS ALONG THE PROPOSED PIPELINE CORRIDOR

County	Name	Population 1/	Location from Centerline of Pipeline Corridor (in miles)	Approximate Pipeline Mile
Clallam	Joyce	N/A 3/	0.2. N	8
	Port Angeles	16,890	0.1-1.2 N	20
	Sequim	2,555	2.2 N	36
	Blyn	N/A	0.9 N	40
Jefferson	Fairmont	N/A	0.5 N	49
	Port Discover Bay	N/A	0.7 N	50
	Chimacum	N/A	0.9S	55
	Irondale	N/A	1.0 N	56
	Hadlock	N/A	0.1 N	56
Island	Bush Point	N/A	adjacent	62
	Dines Point	N/A	0.9 E	67
	Greenbank	N/A	adjacent on W	60
	Cama Beach	N/A	0.3 N	74
	Saratoga Shores	N/A	adjacent on N	74
	Indian Beach	N/A	1.0 W	76
	Juniper Beach	N/A	0.7 S	84
Snohomish	Stanwood	1,463	adjacent on S	85
	East Standwood	N/A	adjacent on W	87
Skagit	Milltown	N/A	adjacent	92
	Conway	N/A	0.4 W	94
	Mount Vernon	10,082 2/	1.1 W	98
	Avon	N/A	0.1 E	100
	Burlington	3,534 2/	1.0 W	104
	Alger	N/A	0.6 W	117
Whatcom	Samish Lake	N/A	0.8 E	122
	Bellingham	43,160	adjacent	128
	Geneva	N/A	0.7 W	128
	Silver Beach	N/A	0.7 E	129
	Strandell	N/A	0.6 NW	139
	Everson	755	0.7 NW	140
	Nooksack	415	0.6	142
	Sumas	708	0.8 NW	148

Source: Washington Office of Financial Management, Population Trends 1977; U.S. Department of Commerce, Bureau of the Census 1977

1/ Towns for which population data is not available are unincorporated places with populations of less than 2,500 people.

2/ 1975 population.

3/ N/A means not available.

Agriculture

In general, agriculture is a significant land use in western Washington, consisting primarily of improved pasture and truck farming, most often near river floodplains. Individual land holdings are often small, frequently in the range of 5 to 80 acres. Approximately 34 miles (23 percent) of the proposed route traverses land designated by the USDA Soil Conservation Service as prime agricultural land (table 8.4.2-47). Prime agricultural land is designated according to its soil classification and productivity. The Soil Conservation Service has delegated the identification of any unique farmland to local governments. To date, no unique land classifications have been made for the area along the pipeline route.

TABLE 8.4.2-47 PRIME AGRICULTURAL LAND ALONG THE PROPOSED PIPELINE ROUTE

County	Prime Agricultural Land (Miles crossed by pipeline)
Clallam	0.0
Jefferson	1.8
Island	1.2
Snohomish	6.8
Skagit	17.0
Whatcom	6.8

Source: TMC 1979

Rangeland/Open Space

Open space lands, (floodplains, unimproved and unirrigated pasture, cleared understory forest, and brush lands), are not of significant extent within the pipeline corridor.

Forest/Woodlands

Forest and woodlands consist of small privately owned woodlots and large corporate-owned and publicly owned forest land. Most of the forest land crossed by the corridor in the Puget Sound region is considered commercially productive.

Special Management Areas

Native American Areas

Indian Reservations are shown in the Map Addendum. The pipeline would not cross or be adjacent to any reservations in Washington.

Natural and Scientific Areas

These are areas in which natural features are preserved for scientific or educational purposes. They may be called research natural areas, nature reserves, range reference areas or natural areas, and may be established under Federal, state or private authority.

The Washington State Marine Atlas references numerous sites used for scientific research. These areas are illustrated in the Map Addendum.

In Island and Snohomish counties the pipeline corridor is adjacent to a scientific research site at Port Susan.

Wilderness

The proposed pipeline corridor does not cross any U.S. Forest Service RARE-II Study areas or Bureau of Land Management designated Wilderness Study areas that have been recommended for wilderness designation or allocated for further planning.

Land Use Plans and Zoning

Local land use plans most often describe policies and goals. Seldom do they specifically address utility corridors. Zoning resolutions generally allow utility-related land uses within most categories, either by right or through a permitting process. It is often a matter of interpretation whether a particular action would be consistent with them. A detailed analysis of land use plans and zoning would be performed concurrent with final route selection.

TRANSPORTATION AND UTILITY NETWORKS

The following section describes transportation and utility networks and related facilities in the vicinity of the proposed pipeline corridor, including waterways, highways, railroads, airports, electric transmission lines, communications installations, and pipelines.

Inland Waterways

The proposed pipeline crosses several waterways including Port Townsend Canal, Admiralty Inlet, Saratoga Passage, and several major streams. A substantial amount of commercial vessel traffic utilizes Admiralty Inlet and Saratoga Passage; however, water transportation near the proposed river crossings is limited to recreation-related traffic.

Roads and Highways

Four interstate and fourteen other primary federal and state highways are crossed along the proposed pipeline corridor.

The existing road network of federal and state highways, county roads, unimproved roads, and BPA and other utility access roads would provide access to the pipeline corridor along the entire route. Aside from urban areas, these roads carry quite low volumes of traffic.

Railroads

Nine major railroads would be crossed by the proposed pipeline. There may be some additional crossing of spur lines and unidentified private rail lines.

Airports

Three private and commercial airports are located along the proposed pipeline route. There may be additional small landing strips in or near the corridor.

Electric Transmission Lines

Two major transmission lines are crossed, and one paralleled, along the proposed route. In urban and rural areas, there would be many local distribution lines crossed by the pipeline. The location of such crossings would not be known until the time of detailed route surveys.

Communications

In urbanized areas the proposed pipeline would cross and parallel many underground and overhead communication lines including telephone and cable TV. The numbers and locations of these facilities would not be known until final route survey and design were completed.

Unaffiliated Pipelines

Various types of pipelines would be crossed or paralleled along the pipeline route. Five major pipeline crossings have been determined so far. In urbanized areas, many smaller pipelines such as natural gas, water, sewer, and storm sewer pipelines also would be crossed. The locations of these smaller local pipelines would be obtained from utility offices at the time of detailed land surveys.

RECREATION

Since most of the proposed pipeline corridor parallels existing rights-of-way, recreation impact is of minor importance. Parks or recreation areas along the corridor are identified in table 8.4.2-48. Most recreation adjacent to the corridor is related to use of forest resources. Big-game hunting, stream fishing, camping, and other dispersed uses (hiking, off-road vehicle recreation) occur here. Intense recreational use of nearby Lake Crescent occurs during the summer with all campsites filled each day.

Much of the proposed route would be within several miles of the Olympic National Forest and Olympic National Park. The Heart O'the Hills District of the Park is the most widely used entrance. Of the 2.9 million recorded visits to the park in 1978, 534,613 used this district. The visitor information center, within 1 mile of the proposed pipeline, recorded 171,439 visits (1978 data). Many tourists taking the Port Angeles-Victoria, B.C., ferry stop at the visitor's center.

Marine recreation resources and activities in the Puget Sound crossing area have been addressed in the Port and Onshore Storage section. Casual day use of island shorelines and inlets is common. Whidbey Island residents have identified tourism as a viable industry they wish to promote. The extent of tourist activity is unknown.

The Skagit Wildlife Recreation area, within an hour's drive of Seattle, is noted for a population of snow geese and excellent waterfowl hunting. Non-hunting recreation, such as photography and wildlife viewing, is also significant. Total recreational use of this area was 73,450 visits in 1978.

TABLE 8.4.2-48 SIGNIFICANT RECREATION AREAS ALONG
THE PROPOSED PIPELINE CORRIDOR

Name	County	Location Pipeline Mile	Visitors Use Days	Comment
Lyre River Campground	Clallam	1	930	1978 summer use, small campground.
Lake Crescent Area	Clallam	5		Popular stop in Olympic National Park, several campgrounds, high scenic values.
Salt Creek Recreation Area	Clallam	10	159,000	1978 day use only. Does not include campground use.
Freshwater Bay Boat Launch	Clallam	11		Use not available.
Olympic National Park Visitor Center	Clallam	21	171,439	1978 use.
Sequim Bay State Park	Clallam	40	865,185	1978 use includes overnight boat moorage, campers and day use.

TABLE 8.4.2-48 (Continued)

Name	County	Location Pipeline Mile	Visitors Use Days	Comment
Anderson Lake State Park	Jefferson	58		
Oak Harbor Beach Park	Jefferson	59		
Mystery Bay State Park	Jefferson	59	65,302	1978 use which includes numbers of visitors using overnight moorage. One of the fastest growing parks. 39% increase in use since 1977.
South Whidbey Island State Park	Island	66	106,171	1978 use includes day and overnight camping.
Camano Island State Park	Island	74	323,607	1978 use includes overnight moorage camping and day use.
Skagit Wildlife Recreation Area	Snohomish	85	73,449	1978 use primarily nonconsumptive wildlife and waterfowl hunting.
Whatcom Falls City Park	Whatcom	128		City park near Whatcom Lake.

Employment

Employment data for each of the six counties along the proposed pipeline route are shown in table 8.4.2-49. Total employment in these counties in 1970 was 163,405. Of the total labor force in the 6 counties, 14,954 persons (8.3 percent) were unemployed, slightly above the statewide unemployment rate of 7.9 percent.

Personal Income

Per capita and median family incomes for the six counties along the proposed pipeline route also are listed in table 8.4.2-49. Snohomish was the only county along the route with a median family income level above the statewide average of $10,404 in 1969. The lowest median family incomes in 1969 were in Clallam ($8,613) and Island ($8,705) Counties.

Property Taxes

The 1971-72 total property tax collections for each county along the proposed pipeline route are shown in table 8.4.2-49. Retail sales in Washington are subject to a basic state sales tax rate of 4.6 percent. This rate includes a temporary increase of 0.1 percent (4.5 to 4.6 percent) effective June 1, 1976 through June 30, 1979. Counties and cities are also allowed to levy a 0.5 percent local retail sales tax, resulting in a combined state and local sales tax of 5.1 percent (scheduled to revert to 5.0 percent on July 1, 1979). In addition, metropolitan municipal corporations are allowed to levy up to 0.3 percent retail sales tax for the support of public mass transit. The total sales tax rate for most of the counties along the route (Clallam, Jefferson, Skagit, and Island) is 5.1 percent. Portions of Snohomish County and Whatcom County levy transit taxes at a rate of 0.3 percent.

TABLE 8.4.2-49 ECONOMIC PROFILE FOR COUNTIES ALONG THE PROPOSED PIPELINE ROUTE

County	Employment (1970)		Money Income		Local Government Finances
	Civilian Labor Force	Unemployed Rate (Percent)	Per Capita Income (1974)	Median Family Income (1969)	Total Property Taxes (1971-72) (millions)
Clallam	12,580	7.5	$4,500	$ 9,213	$5.5
Island	7,124	10.0	4,362	8,705	3.3
Jefferson	3,902	6.8	4,242	8,848	2.1
Snohomish	104,173	8.7	4,705	10,884	52.9
Skagit	19,758	8.4	4,491	9,389	10.3
Whatcom	30,806	7.5	4,395	9,431	16.4

Source: U.S. Department of Commerce, Bureau of the Census 1977

Infrastructure

Populations for counties along the proposed route are displayed in table 8.4.2-50. In 1975, these six counties had 14 percent of the state's total population.

There would be no significant effects on the infrastructural components of five of these counties (Clallam, Jefferson, Snohomish, Skagit, and Whatcom). One reason for this is the location of the proposed route. Through Skagit and Whatcom Counties the pipeline will be located on or adjacent to the existing TMC right-of-way. In Clallam and Jefferson Counties 26 miles of the route will be within an existing transmission line corridor.

A second reason pertains to the proposed construction schedule. Estimates are that construction would proceed at a rate of one-half mile per day and that no specific locale would be affected for more than a two-week period (TMC 1979). Third, since the number of workers and families involved in construction is small compared to the total population, the effects would be insignificant.

Because of this lack of impact further detail on the existing social environment in these counties is not necessary.

This, however, is not the case in Island County nor in various county entities such as Native American Tribal Reservations and small, unincorporated towns along the proposed route.

Whidbey Island, over which the pipeline would cross, is the functional center of Island County. The commercial hub of Whidbey Island is the town of Oak Harbor with an estimated 1979 population of 12,000. Coupeville, the county seat with a population of about 1,000, is approximately 5 miles south of Oak Harbor.

Between 1970 and 1977 there was a 41 percent increase in the Whidbey Island population--from 19,634 to 27,680. The number of houses increased about 32 percent. Vacancy rates have shrunk from 21.5 percent in 1970 to less than 8 percent in 1977 (Island County Comprehensive Plan 1977).

In 1978 Oak Harbor contained 2,859 residential units; 66 percent were one family houses and 11 percent were mobile homes. Coupeville had 455 units; about 65 percent were one family houses and 16 percent were mobile homes (State of Washington Population Trends 1978). Vacancy rates were not reported.

There were 99 hotel/motel units in the area in 1977. In addition there were 9 recreational vehicle spaces in Oak Harbor, and 20 spaces in Coupeville (SRI International 1978).

Three elected County Commissioners serve Island County residents. County government facilities are located primarily in Coupeville. The present facilities, although expanded in the mid-1970's, are relatively crowded.

TABLE 8.4.2-50 SOCIOECONOMIC DATA FOR COUNTIES ALONG THE PROPOSED PIPELINE ROUTE

County	Population (1975)		Housing (1970)			Medical Service (1975)		
	Population	Persons per Square Mile	Total Year-Round Units	Occupied Year-Round Units	Vacancy Rate (percent)	Hospitals	Beds	Physicians
Clallam	40,383	23	12,552	11,681	7.0	2	120	50
Island	32,398	153	12,016	8,400	30.0	1	44	18
Jefferson	12,016	7	4,438	3,666	17.3	1	59	16
Snohomish	264,202	126	88,056	81,463	7.5	5	670	243
Skagit	53,202	31	18,935	17,149	9.4	3	283	103
Whatcom	89,842	42	29,867	26,720	10.5	2	100	116

Source: U.S. Department of Commerce, Bureau of the Census 1977
Washington Department of Social and Health Services, Directory of Licensed Hospitals 1978.

Oak Harbor residents are governed by an elected city council. City administrative affairs are conducted by a full-time manager and staff.

Altogether, 32 residential communities are identified by TMC as locations through or around which the proposed pipeline will pass. Only three of these (Port Angeles, Mount Vernon, Bellingham) have 10,000 or more residents. Three others, Sequim, Stanwood, and Burlington, have populations exceeding 2,500. The remaining communities have populations ranging from 100 to 2,500 (State of Washington Population Trends 1977).

Detailed data on infrastructure are not available, but generally these small, unincorporated communities have a limited amount of housing and vacancy rates. Many are provided with domestic water by privately owned water companies. Sewage disposal is by septic tanks. Other services, such as education, medical, and law enforcement are provided by county agencies. Fire protection, where available, is provided by volunteers.

There are three Native American tribal reservations adjacent to or near the proposed pipeline route. These are the Tulalip in Snohomish County, the Swinomish in Skagit County, and the Lummi in Whatcom County.

The Tulalip Reservation contains approximately 9,000 acres. In 1978 there were 583 Native Americans residing on the reservation and another 170 living adjacent to it (BIA). Details were not available on housing, education, or police and fire protection. The Tulalip tribe operates the Jimmicum Springs water system. An elected tribal council represents members of the tribe (Federal and State Indian Reservations 1976).

A total of 393 Native Americans lived on the 7,063 acre Swinomish Reservation in 1978, with an additional 180 on lands adjacent to it. Since 1972 the population of Indians living on or adjacent to the Swinomish Reservation has increased by about 70 percent.

Current information on housing, education, police, and fire organizations is not available. In 1972, 250 of the 306 dwellings on the reservation were owned by non-Indians. Since 1972 the number of residential units has increased due to the development of the Shelter Bay area reservation land leased from the tribe for non-Indian use.

There was no school on the reservation in 1972; children attended public schools in Skagit County. Water supply and sewer systems were installed and maintained by the U.S. Public Health Service. Police protection is available from Skagit County. The LaConner Volunteer Department provides fire protection services (Swinomish Comprehensive Plan 1972).

Government is under the jurisdiction of the Swinomish Tribal Senate which elects executive officers, employs a tribal manager, and delegates responsibilities to a number of committees. A comprehensive plan for the reservation was approved in 1972.

The Lummi Reservation contains 7,320 acres. In 1978 there were 1,733 Native Americans living on the reservation, and another 814 living adjacent to it (Bureau of Indian Affairs 1978). Since 1972 the population has increased by 76 percent. Current data was unavailable for housing, schools, and police and fire protection. Local wells and septic tanks are used in some parts of the reservation. Water and sewer systems, constructed in the past decade, serve some residential areas. A clinic, operated by U.S. Public Health Service, provides medical care. Bellingham medical personnel and facilities provide contract health care services.

Lummi Tribal government is the responsibility of the Lummi Business Council. Seven standing commitees execute the plans and policies of the business council. The Lummi constitution was approved by the Federal government in 1970, but the tribe does not operate under the terms of the Indian Reorganization Act of 1934 (Federal and State Indian Reservations 1976).

Social Well-Being and Quality of Life

Whidbey Island consists of approximately 170 square miles; 17 square miles are under federal, state, or county jurisdiction (including the naval installations). An estimated 39 square miles is covered by forest. The overall population density for the 114 square miles available for residential purposes (including agriculture) was 172 persons per square mile in 1977 (Comprehensive Plan 1977).

Specific data on population age distribution of Whidbey Island were not available. In Island County, however, the age distribution figures indicated that 48.5 percent of the 1975 population were under age 20. Only 9.8 percent were over age 65. In 1975 the median age in the county was reported at 25.8 years, compared to 29.1 years for the state (Washington State County Population Forecasts 1978).

Employment opportunities in Island County are relatively limited. Employment in the two sectors of government (29.5 percent) and retail trade (25.4 percent) accounted for more than one half of all jobs in 1977 (Pocket Data Book: State of Washington 1978). Unemployment was at 9.0 percent in 1976 (SRI International).

Whidbey Island residents have access to all county services. The County Planning Department's Comprehensive Plan, based on current land-use data, provides 25-year projections. county and municipal officials are accessible for meetings with the general public.

In 1978 unemployment rates for the work force were as follows: Tulalip, 33 percent; Swinomish, 48 percent; and Lummi, 55 percent. In 1978, the total number of workers on the Tulalip Reservation was 247, with 140 workers on the Swinomish Reservation, and 600 workers on the Lummi Reservation.

Indicators of the quality of life for residents of Whidbey Island attain relatively high ratings. People on the island follow a fairly casual lifestyle consistent with a rural and small town atmosphere.

Recreational opportunities are abundant and varied. Marine-oriented activities are actively pursued.

Public schools in Oak Harbor and Coupeville were crowded in 1977. Capacity in the Oak Harbor District schools was estimted at 4,292 while enrollment was reported as 5,542. Coupeville District schools had a capacity of 491 with 658 enrolled (SRI International). A community college in Oak Harbor has a 2-year curriculum and offers specialized classes to adults.

Resident awareness of air and water quality is high. Two citizen organizations are actively concerned with the maintenance and continued improvement of the air and water. While the two organizations at times will differ in their emphases, basically they both serve, through frequent meetings and publicity, to keep residents aware of conservation and environmental concerns.

Whidbey Island attracts a broad range of people. According to the Island County Comprehensive Plan (1977) a "significant proportion" of new arrivals to Whidbey Island is composed of retirement age people. The plan states that "large groups" of young people reside in the northern Whidbey Island area.

Improvements to the quality of life on the Native American tribal reservations are needed. Concerned tribal leaders actively support local and intertribal efforts to effect improvements. They also feel that reservation quality of life will improve with expanded educational and employment opportunities, better health care and housing, and stronger local (tribal) government authority.

Many Native Americans prefer reservation life over off-reservation environments despite quality of life problems, as shown by population increases on each of the three reservations.

8.4.3 ENVIRONMENTAL IMPACTS

Environmental impacts resulting from construction, operation, and abandonment of the proposal are identified and discussed in this section.

Most impacts are described in qualitative terms. Detailed construction, operation, and abandonment plans are not completed. The port facilities are described in terms of preliminary design; the pipeline route is described in terms of a 2-mile-wide corridor. This information is not sufficiently detailed to quantify most site-specific impacts. Individual impacts could vary significantly depending upon site-specific details of project design and methods of construction, operation, and reclamation.

Impacts are addressed for the port facilities and pipeline system. Each of these two major components are discussed by environmental concern and for three phases of the proposal: construction, operation, and abanonment.

The sea leg for the TMC proposal is the area of the ocean traversed by oil tankers from Alaska and foreign ports to Cape Flattery, Washington. This vast area has not been considered in detail in this statement.

PORT AND ONSHORE STORAGE FACILITIES

OIL SPILL, FIRE, AND EXPLOSION RISK ANALYSIS

Transshipment of crude oil entails a certain risk of spillage with each separate operation within the transportation system; from source to refinery. Risk is associated with in-transit tanker spills, at-berth spills, bunkering barge spills, offshore and onshore pipeline spills, onshore storage facilities spills, and fire and explosion.

Data concerning anticipated amounts of crude oil to be handled, methods of handling, and records of results of past handling can be mathematically treated to estimate probabilities of occurrence of oil spills, fires, or explosions of various magnitudes. They are usually expressed as such an event happening once in a given time period, as one spill of over 1,000 barrels in 10 years. It must be emphasized that this is only a mathematical probability, and that such a spill might occur 2 years in a row, not at all in 10 years, or tomorrow.

The following section addresses oil spill risk associated with the port facilities and pipeline system. For both discussions it was assumed that the factors historically contributing to risk would remain constant throughout the life of the project.

The selection of a variable describing the spill risk of oil is influenced by the availability of appropriate data. The analysis presented utilized exposure variables and compatible risk factors developed by the Oceanographic Institute of Washington (OIW 1978a,b,c 1979) and by the Pollution Incident Reporting System (PIRS) reports from 1973 to 1976. These variables and risk factors also were applied in the evaluation of potential oil spill risk for TMC.

Tanker Risk Analysis

In-transit Tanker Risk

It has been determined that distance traveled and port calls per year provides an adequate exposure variables for risk evaluation within U.S. ports for oil spill incidences greater than 100 gallons (about 2.4 barrels) from vessels intransit within a port zone (OIW 1978 a,b,c).

Oil spill risks from existing oil transshipment systems are evaluated and the additional risk from any transshipment systems considered. Estimates of frequencies of spill magnitudes for existing tankers in-transit to harbors within Greater Puget Sound are given in table 8.4.3-1. The existing risk for an intransit oil spill of at least 2.4 barrels, is one spill every 1.2 years.

TABLE 8.4.3-1 ESTIMATES OF FREQUENCIES OF SPILL MAGNITUDES FOR EXISTING TANKERS IN TRANSIT TO HARBORS WITHIN GREATER PUGET SOUND 1/

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 2/ (years per spill) one spill every:
2.4-10	2.5 years (1.5 - 8.6)
10.1-50	5.6 years (3.3 - 99)
50.1-100	24.3 years (14 - 83)
101-200	14.5 years (8.5 - 50)
201-2000	18.3 years (11 - 63)
2001-10,000	14.5 years (8.5 - 50)
10,000	36.1 years (21 - 124)
A spill ≥ 2.4	1.2 years
95% confidence limits	(0.7 - 4.1)

Source: OIW 1978 a,b,c

1/ Based on the total average number of port calls per year (average over the years 1973 to 1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year) and the distances traveled to each harbor.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical spill rate.

At the design crude oil throughput of 500,000 barrels per day (bpd), the TMC system would require 205 annual tanker port calls at Low Point. Transit distance traveled in the Strait of Juan de Fuca to Low Point is 42 nautical miles. Consequently, the expected annual frequency of an oil spill over 2.4 barrels from a tanker is 0.1208 (1 spill every 8.3 years).

An average spill size of approximately 2,500 barrels (with a median spill size between 10 and 50 barrels) would be expected in such an event. The oil spill frequencies for large spills are shown in table 8.4.3-2

TABLE 8.4.3-2 FREQUENCY OF LARGE SPILL MAGNITUDES FOR IN-TRANSIT TANKERS TO LOW POINT

Spill Size Greater Than	Spill frequency one spill every:
2,000 barrels	60 years
10,000 barrels	168 years
50,000 barrels	943 years
100,000 barrels	2,677 years

Source: TMC 1979

The total existing in-transit fire and explosion risks for tankers traveling to ports within greater Puget Sound are one fire every 35 years and one explosion every 31 years. These data are given in tables 8.4.3-3 and 8.4.3-4. The frequency of a fire and explosion on in-transit tankers to Low Point is 211 years and 201 years, respectively (TMC 1979).

TABLE 8.4.3-3 ESTIMATED FIRE FREQUENCY FOR TANKERS TRAVELING TO HARBORS WITHIN GREATER PUGET SOUND EXISTING FIRE RISK - COASTAL AREAS 1/

Harbor	Fire Frequency one fire every:
Tacoma	270 years
Seattle	110 years
Anacortes	220 years
Cherry Point	99 years
Port Angeles	2,100 years
Total existing tanker risk 2/	35 years

Source: OWI 1979

1/ Coastal areas extend from harbor entrances to 50 miles offshore.

2. Based on the total average number of port calls per year (average over the years 1973-1976) to the five largest tanker harbors-of-call within greater Puget Sound (513 port calls/year) and the distances traveled to each harbor.

TABLE 8.4.3-4 ESTIMATED EXPLOSION FREQUENCY FOR TANKERS TRAVELING TO HARBORS WITHIN GREATER PUGET SOUND EXISTING EXPLOSION RISK - COASTAL AREAS 1/

Harbor	Explosion Frequency one explosion every:
Tacoma	240 years
Seattle	95 years
Anacortes	200 years
Cherry Point	88 years
Port Angeles	1,800 years
Total Existing Tanker Risk 2/	31 years

Source: OIW 1979

1/ Coastal areas extend from harbor entrances to 50 miles offshore.

2/ Based on the total average number of port calls per year (average over the years 1973-1976) to the five largest tanker harbors-of-call within Greater Puget Sound (513 port calls/year) and the distances traveled to each harbor.

Tankers at Berth Risk

Estimations of berth risk have been derived from statistics of ports using non-fixed berths or single point moorings (SPM). These risk projections do not depend explicitly on the specific characteristics of the port at Low Point. The risk projections imply that if the port meets the operating standards acceptable for U.S. ports for eventual configuration and navigation rules, the risk of spills and casualties would be equivalent to other of U.S. ports of the same class.

Standby requirements (queuing) can be estimated from the assumption that the arrivals of the vessels are probabilistic. With 205 annual port calls, the average arrival interval would be 42.7 hours. During any 48-hour period, the probability of arrivals would be:

no arrivals -- 33 percent;
one arrival -- 37 percent;
two arrivals -- 21 percent;
more than two arrivals -- 9 percent.

Thus, about 9 percent of the time, the moorings would be occupied when a vessel arrives and a standby location would need to be utilized. The average (mean) berth utilization time would be about 56 percent The periods in which weather will not permit operations, would tend to increase the queuing slightly.

Assuming 205 annual port calls at Low Point, 2.46 oil spills in excess of 3.6 barrels (150 gallons) would be anticipated. The average spill size would be 115 barrels, with a median spill size of less than 10 barrels. Table 8.4.3-5 shows the probability of spills by size.

TABLE 8.4.3-5 FREQUENCY OF MAGNITUDES FOR TANKER OIL SPILLS AT BERTH AT LOW POINT

Spill Size Greater Than (barrels)	Average Spill Frequency (years) one spill every:
10	1.3 years
50	4.8 years
100	7.7 years
200	13.2 years
2,000	59 years
10,000	203 years

Source: TMC 1979

Total existing fire and explosion risks for tanker utilizing ports within greater Puget Sound are shown in tables 8.4.3-6 and 8.4.3-7. One fire casualty could occur every 15 years and one explosion casualty might occur every 37 years.

TABLE 8.4.3-6 ESTIMATED FIRE FREQUENCY FOR TANKERS UTILIZING HARBORS WITHIN GREATER PUGET SOUND EXISTING FIRE RISK - HARBOR AREAS 2/

Harbor 1/	Fire Frequency one spill every
Tacoma	140 years
Seattle	49 years
Anacortes	83 years
Cherry Point	43 years
Port Angeles	480 years
Total existing tanker risk	15 years

Source: OIW 1979

1/ Based on the total average number of port calls per year (average over the years 1973-1976) to the five largest tanker harbors-of-call within Greater Puget Sound (513 port calls/year).

2/ Harbor areas include the harbor entrance, harbor entrance, river or canal, and berth.

TABLE 8.4.3-7 ESTIMATED EXPLOSION FREQUENCY FOR TANKERS UTILIZING HARBORS WITHIN GREATER PUGET SOUND EXISTING EXPLOSION RISK - HARBOR AREAS 1/

Harbor	Explosion Frequency one explosion every:
Tacoma	350 years
Seattle	120 years
Anacortes	200 years
Cherry Point	100 years
Port Angeles	1,200 years
Total existing tanker risk 2/	37 years

Source: OIW 1979.

1/ Harbor areas include the harbor entrance, harbor, river or canal, and berth.

2/ Based on the total number of port calls per year (average over the years 1973-1976) to the five largest tanker harbors-of-call within Greater Puget Sound (513 port calls/year).

A fire at the Low Point port would be expected to occur once every 45.8 years. An explosion at the Low Point port would be expected to occur once every 112.2 years. (TMC 1979).

Bunkering Barge Risk Analysis

The spill frequencies shown in table 8.4.3-8 represent the existing risk associated with the current annual tank barge port calls at ports within greater Puget Sound. A tank barge spill equal to or greater than 2.4 barrels could occur every 0.27 years.

Assuming that every tanker would bunker once or more, a minimum of 205 and a maximum of 407 bunkering barge calls per year can be projected at Low Point. The mean frequency of spill sizes for the mimimum and maximum expected number of barge calls at Low Point is shown in table 8.4.3.9.

TABLE 8.4.3-8 ESTIMATED FREQUENCIES OF SPILL MAGNITUDES FOR THE EXISTING TANK BARGE TRAFFIC IN GREATER PUGET SOUND 1/

Spill Magnitude (in barrels)	Spill Frequency and Uncertainty 2/ (years per spill) one spill every:
2.4-10	0.42 years (0.26-0.90)
10.1-50	1.27 years (0.80-2.72)
50.1-100	5.74 years (3.62-12.3)
101-200	7.71 years (4.86-16.6)
201-2,000	14.4 years (8.95-30.5)
A spill ≥ 2.4	0.27 years
95 percent confidence limits	0.17 - 0.58

Source: OIW 1978

1/ Based on the average number of tank barge port calls (3,521 port calls/year made in Greater Puget Sound from 1973 to 1976.

2/ The ranges shown in parentheses for each spill size are estimates of the 95 percent confidence limits based on the derived historical tank barge spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the date for all spills from tank barges.

TABLE 8.4.3-9 FREQUENCY OF SPILL MAGNITUDES FOR BUNKERING BARGES AT LOW POINT

Spill Size Greater than (barrels)	Average Frequency (years) 205 port calls one spill every	407 port calls one spill every:
2.4	4.65 years	2.34 years
10	13.2 years	6.6 years
50	33.6 years	17.0 years
100	50.0 years	25.0 years
201	82.0 years	44.0 years
2,000	245.0 years	123.0 years

Source: TMC 1979

Submarine Pipeline Risk Analysis

Using the underwater spill factor applied to pipelines in Puget Sound (OIW 1978c), the estimated recurrence interval for oil spills is about 238 years for a 5-mile exposure (two submarine lines 2.5 miles long). In other words, over a 20-year period, the chances of a spill would be roughly 8 percent (TMC 1979).

Onshore Storage Facilities Risk Analysis

The estimated existing frequency of storage facilities spill magnitude is for the maximum storage of 30,5 million barrels in greater Puget Sound. An oil spill from storage tanks, equal to or greater than 2.4 barrels could occur every 0.19 years. These data are presented in table 8.4.3-10.

TABLE 8.4.3-10 ESTIMATES OF FREQUENCY OF STORAGE FACILITIES SPILL MAGNITUDES FOR THE MAXIMUM STORAGE VOLUME OF THE GREATER PUGET SOUND AREA

Spill Magnitudes (in barrels)	Spill Frequency and Uncertainties 1/ (years per spill) one spill every:
2.4 - 10	0.53 years (0.43-0.68)
10.1 - 100	0.38 years (0.31-0.50)
101 - 1,000	1.40 years (1.14-1.80)
1,001 - 10,000	17.3 years (14.1-22.2)
A spill ≥ 2.4	0.19 years
95 percent confidence limits	0.16 - 0.24

Source: OIW 1978c.

1/ The ranges shown in parentheses for each spill size, are estimates of the 95 percent confidence limits based on the derived historical tank farm spill rate, and were calculated by assuming that the variance of the data for all spills from tank farms.

The frequency of one spill every 2.9 years (0.34 spills per year.) could occur at the Low Point onshore storage facilities if an average of 50 percent of the 4 million barrel storage capacity were used (TMC 1979).

Frequencies for various spill sizes are shown in table 8.4.3-11.

TABLE 8.4.3-11 FREQUENCIES FOR SPILLS AT THE ONSHORE STORAGE FACILITIES AT LOW POINT

Spill Size Greater than (barrels)	Average Frequency (years) one spill every:
2.4	2.94 years
10.0	4.6 years
100.0	19.4 years
1,000.0	263.0 years

Source: TMC 1979

Storage facility fires and explosions resulting in damages over $1,000, reported from 1972 through 1976, were evaluated and listed in table 8.4.3-12. Almost half the fires caused damage less than $10,000, but the average loss per fire was about $115,000. (OIW 1979).

TABLE 8.4.3-12 HISTORICAL DAMAGE FROM STORAGE FACILITY FIRES 1/

Fire Loss	Number	Percentage of Total Number
$1,000 to $10,000	8	44
$10,000 to $100,000	4	22
$100,000 to $500,000	5	28
over $500,000	1	6
Total	18	100

Source: OIW 1978c

1/ For fires causing damage over $1,000.

The frequency of events of various damage classes (1975 dollars) would be:

any fire loss over $ 1,000	62 years
10,000	110 years
100,000	181 years
500,000	1,028 years

Thus, there is a 89.5 percent chance that no major losses ($100,000) would occur over the 20-year period and a 10.5 percent chance that one or more major losses would occur.

CLIMATE

The proposed project would have no significant impacts on climate.

AIR QUALITY

No detailed analysis of air quality impacts has been possible due to the absence of on-site meteorological and air quality data. Meteorological data for Port Angeles, about 18 miles east of Low Point, are not necessarily representative of conditions at Low Point. Since wind conditions are very strongly dominated by local topographical effects, it is essential that on-site meteorological data be collected before any reliable estimates can be made on air quality impacts.

Due to significant restraints imposed on allowable changes in air quality as a result of the close proximity to the Olympic National Park, which is a mandatory Class I area, the viability of the proposed project cannot be determined until a thorough modeling analysis has been made. According to EPA guidelines, at least one year on on-site meteorological and air quality data must be gathered in order to have sufficient information to determine compliance with the Prevention of significant Deterioration standards.

This section, therefore, describes impacts qualitatively only. A screening model was used to determine whether or not there would be potential problems in meeting air quality standards. A limited modeling analysis was performed for SPM site at Low Point for the proposed NTPC project (SAI 1978). Results of this study can also give some estimates of potential air quality impacts.

Construction Phase

Construction equipment would emit hydrocarbons, sulfur dioxide, particulates, nitrogen oxides, and carbon monoxide. The emissions would vary with the type and amount of construction equipment operating. Table 8.4.3-13 presents the maximum expected emission rates associated with construction activities (SAI 1978). Other pollutants include fugitive dust during construction of the onshore storage facilities, and hydrocarbons from spray painting the storage tanks.

TABLE 8.4.3-13 CONSTRUCTION EMISSIONS
(lbs/working day)

Pollutant	Port Facility	Submarine Pipeline	Onshore Storage Facility
Nitrogen oxides	3,300	3,380	1,140
Carbon monoxide	1,500	1,000	280
Hydrocarbons	460	240	80
Sulfur dioxide	220	230	75
Particulates	150	150	55
Fugitive dust	---	33	10,800
Fugitive hydrocarbons	---	---	600

Construction-related emissions would be temporary and confined to the immediate construction site. No violations of ambient air quality standards would be expected.

Operation Phase

Emissions from operation of the port facility would consist of sulfur dioxide, nitrogen oxides, particulates, hydrocarbons, and carbon monoxide emitted from the tanker stacks. Estimated annual emissions are based on emission factors from SAI (1978) and presented in table 8.4.3-14. The frequency of 205 tanker calls per year proposed by TMC was assumed. It was also assumed that the tankers would burn bunker fuel with an average sulfur content of 2.0 percent.

Based on the analysis performed for the proposed oil port sites for the NTPC and NEC project, the most critical element in meeting air quality stndards is the short-term incremental increase in sulfur dioxide concentrations. Therefore, the EPA VALLEY model was used to determine whether there would be potential violations of those standards.

VALLEY calculates the maximum 24-hour average concentration in regions of complex terrain by assuming stable conditions with a constant wind direction to persist for 6 hours in the 24-hour period. Since the modeling assumptions and meteorological input represent worst-case dispersion conditons, the model result should give an upper limit to the possible concentration.

TABLE 8.4.3-14 ESTIMATED ANNUAL EMISSIONS PORT FACILITY 1/

Pollutant	Stack Emissions (tons/yr)	Ballasting Emissions (tons/yr)
Sulfur dioxide b/	1,264	
Particulates	75	
Nitrogen oxides	160	
Hydrocarbons	12	79
Carbon monoxide	2.4	

1/ Based on emission factors from SAI (1978)
2/ Based on burning of bunker fuel with sulfur content of 2.0 percent by weight.

The calculations were made assuming sulfur dioxide emissions from two 200,000 dead weight ton tankers unloading simultaneously. The resulting concentrations indicated occasional violations of the 24-hour Class II incremental stndard for the elevated terrain about 3 miles south of the SPM sites. There also may be occasional violations of the 24-hour Class I incremental standards in the area of Lake Crescent in the Olympic National Park, about 6 miles south of the proposed SPM sites.

In addition to the VALLEY analysis, some estimates of pollutant concentrations can be made by examining the modeling done for Low Point in association with the proposed NTPC project (see chapter 9). Since the throughput for the proposed TMC project would be 500,000 barrels per day compared to NTPC's ultimate throughput of 933,000 barrels per day, air quality impacts would be smaller. These modeling results indicate that sulfur dioxide concentrations would be well within the federal and state ambient air quality standards. However, potential violations of the 3-hour and 24-hour Class I incremental standards in the Olympic National Park were indicated. The modeling study showed no violation of the Class I or Class II incremental standards for particulates. Calculated average annual concentrations for nitrogen dioxide were well within the ambient air quality standard.

A more thorough modeling study using on-site meteorological data would be required to determine definitely whether the Class II and Class I increments for sulfur dioxide would be met. It may be necessary for the tankers to burn low-sulfur fuel while unloading in order to prevent violations of the incremental standards.

Hydrocarbon emissions from ballasting could increase ozone levels. A study performed by SAI (1978) for the NTPC indicated changes in ozone levels would be slight, with concentrations well within the standard. Therefore, no hydrocarbon violations would be expected for the TMC proposal.

The onshore storage facility would emit hydrocarbon vapors from the storage tanks, pump stations, and associated valves and seals Estimated emissions from these sources are given in table 8.4.3-15. Hydrocarbon emissions would not be sufficient to cause any increase in ozone concentrations

TABLE 8.4.3-15 ESTIMATED ANNUAL HYDROCARBONS EMISSIONS, ONSHORE STORAGE FACILITY

Source		Emission Rate (tons/yr)
Storage tanks		123.0
Valves and Seals		10.9
Pump Station		5.4
	Total	139.3

Based on emission factors from SAI (1978)

NOISE

Noise impacts were based on NTPC's analysis (1979). Since most of the components of TMC's proposal would be very similar, noise impacts would be comparable.

Construction Phase

Construction at the port and onshore storage facilities would result in temporary high noise levels in the vicinity of Low Point. Construction would occur over 20 months. The highest noise level probably would occur from pile drivers. Other noise sources would include concrete trucks, cranes, air compressors, other construction equipment, barge, and tugboat activities. In Washington, noise levels resulting from temporary construction activity are exempted between the hours of 7 a.m. and 10 p.m.. Construction noise levels would be about 60 to 70 dba for the nearest residences based on NTPC's analysis. As there is practically no industrial or other man-caused noise in the area now, this would be noticeable and annoying to the few residents.

Operation Phase

The primary noise source at the onshore storage facilities would be operation of the electric pumps,operating 24 hours per day. The maximum noise level at 100 feet would be about 64 dBA (TMC 1979). No receptors are anticipated to be impacted.

Abandonment Phase

Abandonment noise would be similar to construction noise.

TOPOGRAPHY AND GEOLOGY

The TMC project would or cause little or no geologic impacts. A landslide or earthquake could result in system failure causing an oil spill.

Geological science, while able to identify potential catastrophic events, cannot reliably predict the time and magitude of occurrence (Foxworthy pers. comm. 1978).

The probability and magnitude of any event occurring at a specific time is based largely on its history (the number of times it occurred, its magnitude, and the interval between events); the physical and chemical properties and the condition of the material, including the degree of weathering and stress; and the configuration of the terrain. Gaps in the geologic data base, particularly historical records of geological events, make estimates of the probability and magnitude of any geologic event occurring during the project unreliable.

The following terms will be used whenever quantification of geologic events is not possible.

Insignificant:	Any geological process or event that would cause no discernible damage to the crude oil transportation system.
Significant:	Any geological process or event that would result in sufficient damage to the crude oil transportation system to warrant repair but would not result in an oil spill.
Critical:	Any geological process or event that would result in an oil spill.

Topography

Construction Phase

Construction of the onshore storage facility at Low Point would change about 300 acres from gently rolling terrain to an esentially flat area with diked units for the storage tanks. Regional topographic impact would be insignificant.

Excavation across the beach and to the storage site would disturb about 3 acres and change land contours in that area. Topographic impact would be lasting but not of regional significance.

Operation Phase

Operation of the onshore storage facilities would have no discernible impact on the topography.

Abandonment Phase

Abandonment of the onshore storage facility and restoration of the site would return the site approximately to its original topographic condition. Topography would be slightly modified at the pit which provides backfill material to fill in and grade low areas on site after structures are removed. As the coastal bluff could not totally be returned to its original configuration a permanent scar would remain.

Geology

Construction Phase

The tanker unloading berths would be entirely waterborne; construction of these facilities would have no impact on geologic materials. No information is abailable on the amount and type of geologic material displaced during trenching operations for the submarine pipeline; an assessment of the resulting impacts is not possible.

While construction activities at the onshore storage facilities would change the physical characteristics of the displaced geologic material, increasing erosion and potential for slope failure, the degree of change has not been determined. No data on the amount of geologic material displaced for the onshore storage facilities are available; an assessment of the resulting impacts cannot be made.

Operation and Abandonment Phases

No impacts have been identified.

Geological Hazards

Construction Phase

Seismicity. The only anticipated hazard would be a large earthquake (6+ Richter scale). Ground shaking could produce a landslide along the unstable coastal bluffs adjacent to the onshore storage facility, However, large earthquakes are rare in the region.

While ground shaking could cause landslides along the submarine pipeline route, the gentle gradient (about 1 percent) makes a submarine slide unlikely.

Slope Instability. Excavation for the pipeline trench could induce slope failure along the unstable coastal bluff by removing support at the base. Impacts to the bluff could range from minor slumping to mass movements involving several thousand cubic yards of material, and could include loss of life and construction equipment as well as modification of the terrain. Although TMC has indicated that adequate precautions would be taken to prevent slope failure along the coastal bluff, it is not known what these measures are. Consequently, an assessment of the probability of a landslide cannot be made. No slope instability problems are apparent at the onshore storage facilities.

Operation Phase

Seismicity. The only anticipated seismic-related geologic hazards that might be encountered during operations of the port and onshore storage facilities would be ground shaking and liquefaction.

Ground Shaking. A large magnitude earthquake in the Olympic Mountains or Puget Trough regions could generate strong ground shaking, damaging the port or onshore storage facilities. Possible rupture of some portion of the system could occur, causing an oil spill or fire. A strong earthquake could also trigger a landslide on unstable slopes and further damage the facilities.

Earthquake intensities in the Olympic Mountains/Puget lowlands have been moderate to strong, ranging between MMV and MMVIII. Magnitudes have ranged from 5 to 7.3 on the Richter scale. The potential is high for future high level earthquakes.

The potential for damage or failure due to ground shaking depends on design. Since the Puget Lowlands is a region of moderately active seismicity, a large earthquake exceeding design criteria could occur. TMC would be required to design all structures at the port and onshore storage facilities to withstand larger earthquakes than have previously been observed at Low Point. The probability of an earthquake exceeding design criteria during the life of the project is low.

Liquefaction. While liquefaction of marine sediments could occur, impacts on the port facility are expected to be minor. The gentle slope gradient (1 percent) would limit downslope movement. Submarine pipeline distortion would be minimal.

Slope Instability. While slope failure of harbor sediments is possible, the gentle slope gradient would limit downslope movement. However, slope failure along the coastal bluff could remove support at the base of the bluff, causing stress beyond design criteria, and possibly result in an oil spill. Although TMC has indicated that the pipeline will be designed for the existing slope conditions, specific information is not available. Consequently, the potential for a slope failure cannot be determined.

Abandonment Phase

Potential seismic-related impacts would be similar to, but less severe than, those associated with the construction phase.

Mineral Resources

No identified mineral resources would be impacted by construction, operation, or abandonment of the project.

SOILS

Construction Phase

Soil on approximately 300 acres of the onshore storage facilities site would be disturbed or altered by construction. The soil structure would be destroyed during excavation and topsoil disturbed over much of the remaining area. The exposure of soil during construction would increase erosion. Agnew silty clay loam, the dominant soil at the site, could erode at the rate of 3 tons per acre per year without protective surface cover. The amount eroded would depend upon periods of surface exposure, amount and intensity of rainfall, and effectiveness of sedimentation ponds and other erosion control measures. Actual loss from the site would be minor (less than one ton per disturbed acre).

Fugitive dust would be about 1.2 tons per acre per month of construction (SAI 1978). Most of the dust would leave the site. The total amount would depend upon of construction activity and wind velocity.

Construction equipment would compact the soil. The amount of lost soil productivity would depend on the degree of ripping, discing, or plowing done to alleviate the compaction. Total loss of productivity would be less than 5 percent.

A slight amount of soil profile mixing would occur despite efforts to stockpile and replace topsoil in the original position.

A significant amount of erosion would occur at the sea bluff where the marine pipeline would ascend to the onshore storage facility site. Excavation here would contribute to the sedimentation of the Strait of Juan de Fuca.

Operation Phase

No significant impacts would occur to the soil from normal operation of the facility. Disturbed areas would be revegetated, reducing soil erosion to 0.02 tons per acre annually (less than one cubic foot per acre). Soil contamination by oil spills, if any, would be confined to areas within retaining dikes. Major oil spills, that escaped the dikes, would contaminate nearby soils, kill protective vegetation, and reduce soil productivity. This impact would not be severe as it is not in an area of intense cultivation.

Abandonment Phase

Removal of structures would disturb surface soils at the site. Soils also would be disturbed at the site from which fill material would be obtained to backfill holes and depressions resulting from removal of facilities.

AQUATIC RESOURCES

This section addresses freshwater resources.

Physical Components

Construction Phase

During construction of the onshore storage facility, soils would erode during moderate to heavy rainfall. Slight increases in suspended sediment and siltation would be expected in Murdock Creek, Susie Creek, and the Lyre River.

Shallow ground water pockets would be removed during leveling and earthwork activities. The ground water level would not be expected to change significantly from these localized activities.

Hydrostatic testing of storage tanks and submarine pipelines would be required. Water would be obtained from local streams or rivers when available; this would temporarily decrease stream flows. After the tests, water would be treated as necessary prior to discharge into the streams or the Strait of Juan de Fuca. No sigificant impacts are expected.

Operation Phase

Much of the onshore storage facility site would be covered with impermeable structures and materials. Recharge to near-surface ground water, which feeds nearby streams, would decrease slightly. Runoff from the diked storage tanks and other developed areas would be collected, retained in holding basins, and processed by the oil-water separators prior to discharge. Under normal operating conditions the discharge would meet the requirements of the NPDES permit issued for the facilities with no significant impacts expected.

The area proposed to be occupied by the 8 storage tanks would be enclosed by a dike approximately 6 feet in height. Oil spills that escape from the diked area or holding basins would contaminate adjacent streams and near-surface ground waters. See the oil spill risk analysis earlier in this section for probability of occurrence.

Abandonment Phase

Abandonment would involve removal of oil from the submarine pipeline and storage tanks. The system would be flushed with water to remove excess oil residue and combustible gases. Quantities of water equivalent to that required for hydrostatic testing would result in similar impacts to water sources. Water would be processed through the treatment system to remove oil before discharge.

Removal of the onshore facilities would temporarily increase soil erosion. Replacement with native soil would increase infiltration and percolation to the ground water.

Biological Components

Construction Phase

Slight increases in suspended sediment and siltation would be expected in Murdock Creek, Susie Creek, and the Lyre River. Impacts on fishery resources probably would not be significant. See the section on impacts to aquatic resources of the pipeline for further discussion.

Operation Phase

Significant impacts during operation of the port facilities could result from accidental oil spills that escaped from containment areas and entered the nearby streams. Offshore oil spills could contaminate the beaches at the mouths of Murdock Creek and the Lyre River.

An oil spill could cause a reduction in fish populations in the streams running between the storage facilities and the ocean. Murdock and Susie Creeks would be most vulnerable to spills from the storage tanks. Whether or not moderate to large spills in Susie Creek would travel to the Lyre River would depend on the effectiveness of containment measures, the prevailing near-shore currents, and surface winds.

Ocean fisheries probably would not be impacted if fish were killed in these local streams. Kills following a large spill might be noticed in sport or Indian river fisheries, particularly if the majority of salmon of the same age died. Any spills that might occur while people are fishing could contaminate gear and temporarily eliminate the fishing by killing or reducing the recreational or food value of the fish.

In addition to fisheries impacts, an oil spill entering nearby streams could also affect populations of aquatic insects and other organisms which serve as food for salmon and trout. A reduced supply of food for these fish could temporarily reduce their growth and survival rates. Additional discussion of oil impacts on fisheries resources is presented under Aquatic Resources, pipeline. Siltation would not be expected to cause significant impacts.

Abandonment Phase

Abandonment of the proposed port facilities could result in a combination of construction- and operation-type impacts. Removal of facilities could lead to minor increases in stream sedimentation. Crude oil, fuel, or oil-contaminated water spills would be possible during the abandonment activity, with impacts similar to those discussed above.

MARINE RESOURCES

This section addresses salt water resources.

Physical Components

Construction Phase

Construction of the two single-point moorings (SPM's) would occur away from the site. They would be barged or towed to their anchorage off Low Point. There would be a slight increase in suspended sediment during anchoring of the SPM's, but no significant impacts are expected.

There will be temporary impacts during installation of the two 48-inch submarine pipelines. Burial of the pipelines would suspend fine-grained sediments causing cloudy water. Trace metals and other chemical compounds bound to the sediments could be released into the water. However, since there are no industries or major developments in the Low Point vicinity, the offshore sediments are not expected to be polluted. A minor change in topographic configuration of the sea bottom would occur.

Local beach erosion and temporary degradation of water quality can be expected during construction of additional shore-based facilities. Fine materials will settle near the small boat anchorage facilities forming a muddy bottom.

Operation Phase

Oil Spill Trajectories

In-transit risks to Low Point begin when tankers enter the Strait of Juan de Fuca at Cape Flattery. Existing risks of in-transit tanker oil spills within Greater Puget Sound is one oil spill of at least 2.4 barrels every 1.2 years (OIW 1978a,b,c). The risk to tankers in-transit to Low Point is one spill every 8.3 years (TMC 1979). The frequencies of the spill magnitudes are given in table 8.4.3-1 and 8.4.3-2.

Hypothetical casualties were considered to occur off Neah Bay, west of Clallam Bay, and at Low Point. A computer model was used to generate oil spill trajectories at each site. No specific spill volumes were considered. Also, each trajectory is merely the movement of the center of a hypothetical oil slick. The model included an empirical tidal current field, an approximate estuarine flow of 10cm/sec (0.2 knot) in March and 30cm/sec (0.6 knot) in September in the central and western Strait regions, a time and space varying wind field, and an empirical "3 percent of wind velocity" oil spill trajectory equation.

The model produced a number of simulated oil spill trajectories used to determine spill impact zones. Other information included tidal current estimates and elapsed time to landfall at each site (Stewart 1978).

In the following discussion, potential impact zones are listed for each site. These zones are estimates of the most probable point of initial impact of an oil spill. Instantaneous small spills at each site can be expected to come ashore somewhere in the zones. Oil spills that occur over a long time interval, such as the Argo Merchant or the Amoco Cadiz oils spills, can be expected to impact most of the shoreline within these zones. Such an assumption is not unreasonable since long spill events will encompass constantly changing weather and ocean conditions (Stewart 1978).

It should be recognized and emphasized that the trajectories do not include all known oil spill transport mechanisms. In the tabulated impact zones oil spreading is completely neglected since there is no agreement on spreading theories and there is a scarcity of spreading data. After the first beaching of oil, part of the oil spill will be refloated on the flood tide and will be transported to another area. Thus, eastward transport from the original beaching site should be expected in the Strait (Stewart 1978). Beached oil on the outer coast would be refloated also, but would be dispersed by ocean waves and transported northward in the winter and southward in the summer.

Oil spill trajectory figures in the following discussions incorporate the oil transport processes in the computer model, as well as a limited attempt to consider transport processed due to spreading, wave action and nearshore currents. These boundary zones were primarily determined by the geographical extremes of the trajectories generated at each site. The impact zones in the figures are qualitative and should not be considered absolute since no spill site is specified and there is no concordance with spreading theories (OIW 1979).

Off Neah Bay. Hypothetical oil spill trajectories from a casualty off Neah Bay and qualitative impact zones for March and September conditions are shown in the Map Addendum. The figure also indicates elapsed time from the start of each trajectory to landfall (or end of trajectory). Table 8.4.3-16 indicates the most likely zones of first oil impact and nautical miles of shoreline within the zones. Although open water trajectories terminate off Cape Flattery, oil spill impacts could occur on the outer coast. During spring conditions the California Current could transport the oil southward to Grays Harbor (see Map Addendum). A winter oil spill could be transported southward, but the Davidson Counter-current would transport most of the oil northward along the coast of Vancouver Island (see Map Addendum).

TABLE 8.4.3-16 MOST LIKELY ZONE OF FIRST OIL IMPACT
(SPILL OFF NEAH BAY)

Spill Site	March Conditions	Nautical Miles of Shoreline	September Conditions	Nautical Miles of Shoreline
Off Neah Bay	Magdalena Point to Jordan River, Canada	22	Owens Point to Clo-oose	15
			Clo-oose, Barkley Sound to Cape Scott, Canada	96 111
	Seal Rock/Sail Rock to Cape Flattery	7		
	and Cape Flattery to Grays Harbor	103 110	Seal Rock/Sail Rock to Cape Flattery	7
			Cape Flattery to Cape Alava	16 23

Source: Stewart 1978; OIW 1978

West of Clallam Bay. Oil spill trajectories for a hypothetical tanker casualty west of Clallam Bay (near Sekiu), in March and September are shown in the Map Addendum. Table 8.4.3-17 lists the initial impact zones. The most likely zones of initial impact in March are between Sombrio Point and Sheringham Point, Canada and from Seal Rock/Sail Rock to Cape Flattery. In September the most likely initial impact zones are from Carmanah Point to Owens Point, Canada and from Seal Rock/Sail Rock to Pillar Point. The terminated open water trajectories west of Cape Flattery would be expected to be influenced by the California Current and Davidson Counter-current. Thus, oil spill impact zones on the outer coast could be from Owens Point to Cape Scott, including Barkeley Sound, Canada and from Cape Flattery in Cape Alara (see Map Addendum).

TABLE 8.4.3-17 MOST LIKELY ZONE OF FIRST OIL IMPACT
(SPILL WEST OF CLALLAM BAY)

Spill Site	March Conditions	Nautical Miles of Shoreline	September Conditions	Nautical Miles of Shoreline
West of Clallam Bay	Sombrio Point to Sheringham Point, Canada	17	Carmanah Point to Owens Point Owens Point, Barkely Sound to Cape Scott, Canada,	11 100 111
	Seal Rock/Sail Rock to Pillar Point	20	Seal Rock/Sail Rock to Pillar Point	20
			Cape Flattery to Cape Alava	16
				36

Source: Stewart 1978; OIW 1978d

Off Low Point. Oil spill trajectories for tankers in-transit and moored off Low Point were simulated for March and September ocean and weather conditions. Spring simulations included a weak estuarine flow of 20 centimeters per second which restricted oil spill impacts west of Port Angeles. The most likely shorelines initially impacted are between Deep Creek and Tongue Point. Early fall trajectories included a 30 centimeters per second estuarine flow. The initial impact zones are between Slip Point/Pillar Point to Cresent Rock and from Cape Flattery to Cape Alava. The initial impact zones are given in table 8.4.3-18 and the trajectories are shown in the Map Addendum. During September conditions, one oil spill was carried by the estuarine flow to the entrance of Cape Flattery. The California Current could transport the oil southward on the open coast (see Map Addendum) and northward if the Davidson Counter-current has developed.

TABLE 8.4.3-18 MOST LIKELY ZONE OF FIRST OIL IMPACT
(SPILL OFF LOW POINT)

Spill Site	March Conditions	Nautical Miles of Shoreline	September Conditions	Nautical Miles of Shoreline
Off Low Point	Deep Creek to Tongue Point	14	Between Slip Point/ Pillar Point to Crescent Rock	20
	Parson Point to Cape Calver, Canada	11	Cape Flattery to Cape Alava	16
	Sooke Basin, Canada	13	Parson Point to Cape Calver, Canada	11
		24	Sooke Basin, Canada	13
				24

Source: Stewart 1978; OIW 1978d

Water Quality

Small, frequent, crude oil and bunker fuel spills would degrade the water quality in the vicinity of Low Point. Should a large tanker accident occur between Cape Flattery and Low Point, the water quality in the western Strait of Juan de Fuca and the outer coast would be severely degraded for a week to several weeks until currents had dispersed the oil and weathering processes had redistributed the crude oil components in the surface slick.

Abandonment Phase

Draining, plugging, and abandoning the submarine pipelines should result in no significant impacts. The only impacts associated with moving the single-point moorings would be minor water cloudiness when the anchors are raised.

Biological Components

This section includes a definition of terms and degrees of impact, a general survey of oil impacts on marine organism, and specific comments on anticipated impacts in individual areas. The areas discussed individually are: outer-coast Cape Flattery to Grays Harbor; Neah Bay to Low Point; Low Point; Agate Bay to Port Angeles; Port Angeles; Green Point; and Dungeness Spit and Bay.

A major impact would result if 40 percent or more of a population would be killed, disabled, or permanently displaced and/or more than 3 months of contamination of a preferred habitat occurs. A moderate impact would occur when 15 to 40 percent of a population would be killed, disabled, or permanently displaced with 1 to 3 months contamination of a preferred habitat. A minor impact would occur when less than 15 percent of population would be killed, disabled or permanently displaced or contamination of a preferred habitat for less than 1 month.

Construction Phase

The physical impacts resulting from construction are described earlier. No major biological impacts are anticipated from the construction of support facilities, the single point mooring, or from pipeline installation from the moorings to Low Point. Moderate and minor impacts that would occur would be restricted to plankton, fish, and bottom life at Low Point. For greater detail see the discussion on Low Point.

Operation Phase

The primary impact on marine life during the operation phase would be from oil spills. Table 8.4.3-19 illustrates some effects of oil on different habitats. Oil can affect an individual organism by direct lethal toxicity; sublethal disruption of physiological or behavioral activities; direct coating; incorporation of petroleum hydrocarbons into the organism; habitat alteration (particularly of substrate characteristics). Items 2 through 5 can all lead to the death of the organism even though death does not immediately. Biological damage from an oil spill can range from comparatively high to nearly total devastation (Blumer and Huss 1972; National Academy of Science 1975). Some of the factors which determine the degree of impact are:

- physical and chemical characteristics of the oil
- amount of oil
- environmental conditions such as salinity, temperature, suspended sediment, substrate, wind, tides, waves, slope of shore
- fate of spilled oil, determined largely by points 1 through 3 above, such as evaporation, dilution and absorbtion on particles
- biological characteristics of the organism, such as species, life stage (adult, larvae) season, size, and previous acclimation.

Summary of Oil Impacts on Various Groups

Plankton. Plankton can be divided into two groups - phytoplankton (tiny plants) and zooplankton (tiny animals). Many marine organisms are planktonic during their early life stages but not as adults. Anderson (1975) considers phytoplankton to be among the marine organisms most sensitive to oil. Miranov and Lanskaya (1969) and Strand, et al. (1971) reported that oil generally retards the growth of phytoplankton. Miranov (1969, as cited by Miranov 1972) stated oil concentrations of .01 to 1,000 ppm prevented or delayed cell division and that concentrations of .1 to 1000 ppm resulted in death. Great differences occur among different species, which means that major changes in population structure could result from an oil spill.

Shiels, Goering, and Hood (1973) studied the effects of Prudhoe Bay crude oil on phytoplankton and marine vegetation in Port Valdez, Alaska. Their findings: 1) concentrations of crude oil necessary to inhibit photosynthesis varied with physical and chemical factors, species abundance, and season. During June a 50 percent inhibition of photosynthesis occurred with 2.0 ppm concentration, 2) very low concentrations of crude oil stimulated photosynthesis during December, April, and June. 3) High natural light levels appear to increase the toxicity of the oil. Although impacts to phytoplankton could be major in the vicinity of a spill, expected recovery would be fast due to effective reproductive and dispersal mechanisms, large populations, and wide distribution.

Zooplankton are also sensitive to oil. Many bottom dwelling animals have zooplanktonic larval stages. These larval plankton stages would be particularly vulnerable since many are concentrated near the surface. Oil spills could seriously damage year classes of certain species. Parker (1970), Conover (1971), and other investigators have found that many species of zooplankton ingest large quantities of oil and then eliminate it in the form of fecal matter. This oil, precipated out as fecal matter becomes incorporated in the sediment. Also, this grazing effect exposes planktivores to the ingested oil in the organisms upon which they feed. Lee (1975) showed that plankton off the coasts of California, British Columbia, and the Arctic take up hydrocarbons and retain it even after moving to clean sea water. Thus zooplankton could pass petroleum hydrocarbons up the food chain. As with phytoplankton, zooplankton impacts could be major. Recovery, however, would probably be complete within a few months, with the exception of those species which are plankton only during a few months of their life cycle. Death of the planktonic stage of those species would weaken the year class of that population.

Marine Vegetation. Marine plants are usually less sensitive to oil pollution than marine animals. Two exceptions are phytoplankton, as discussed, and tiny bottom species living between sand grains and pebbles. Skiels, Goering, and Hand (1973) studied the effects of Prudhoe Bay crude on several sea weed species. They stated that photosynthetic response to oiled seawater was different for each species; some showed inhibition at 7 ppm, while others appeared unaffected. Photosynthetic stimulation by crude oil was suggested for some species at low concentrations. Intertidal and shallow subtidal algae can be destroyed when coated with oil; they become overweighted and are torn off the rocks (Spooner 1971). Kelp has a jelly-like covering which is very resistant to oil and provides considerable natural protection. Some kelp in Washington waters are annuals whose reproductive stage lacks the jelly-like covering. If a spill occurred during reproduction the annual algae could suffer major impacts. Templeton (1972) states that oiled annuals rarely recover. The loss of a kelp bed would have a moderate to major impact upon associated species of algae, invertebrates, fish, and marine mammals.

Eelgrass beds provide critical habitat for many species of birds, fish, and invertebrates. British investigators found that even small quantities of oil can weaken eelgrass, making it susceptible to attacks of a parasitic fungus.

Like kelp and eelgrass, salt marsh vegetation is a basic habitat for many species. Salt marsh grass is sensitive to long term impacts from heavy oil pollution (Baker 1971). Light pollution causes little long term damage. If substantial quantities of oil soaks into the base of a plant, its growing points are killed. Also, oxygen is passed through the roots of salt marsh vegetation into the soil. Plant death can result in no oxygen in the surrounding mud. Since bacterial degradation of oil in the mud requires oxygen, the lack of oxygen would greatly retard the natural clean up process.

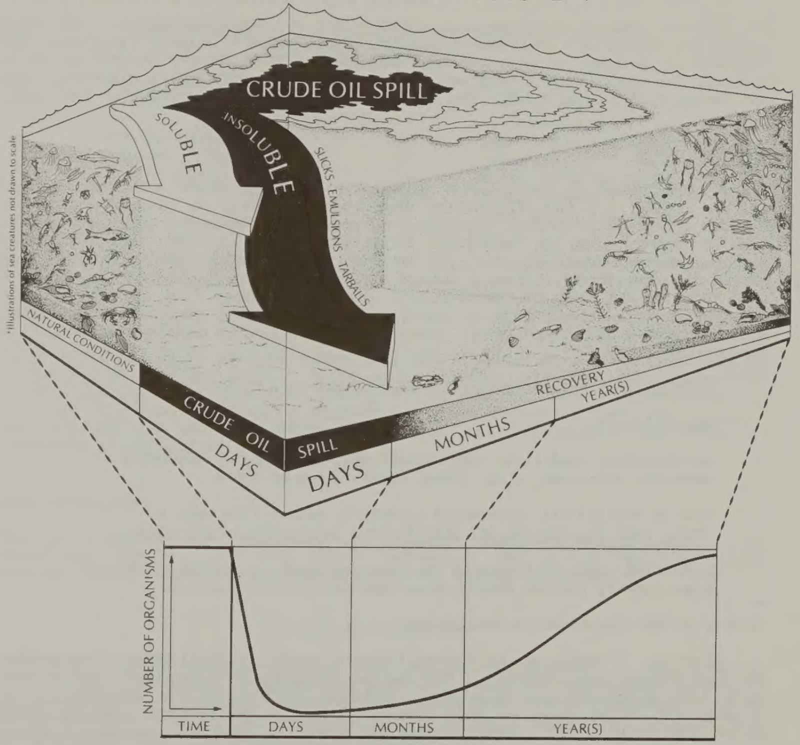
TABLE 8.4.3-19
EFFECTS OF OIL ON MARINE HABITATS[1]/

Habitat	EXPECTED INITIAL IMPACT		EXPECTED RECOVERY	
Rock	Physical -- Slight to moderate	Dissolved hydrocarbons could saturate tide pods on falling tide causing tainting or death.	Fast to moderate	High wave energy regime. Rapidly flused. Heavy coatings may remain in high intertidal until next highest tide.
	Toxicity -- Significant	Tarry residues may smother organisms. Subtidal rock surface unaffected		
Sand	Physical -- Moderate	Burial of oil preserves oil for release when beach erodes.	Fast to moderate	Oil rapidly flushed away on high wave energy beaches. Moderate wave or current energy beaches and subtidal sediments flush more slowly and may retain some oil for long periods.
	Toxicity -- None to slight	Water movement generally sufficient to dilute soluble fractions rapidly.		
Mud	Physical -- Moderate	Low energy wave or current regime in bay estuaries, and subtidal areas. Oil could be incorporated into mud.	Slow	Oil will be deeply mixed by burrowing organisms where degradation will be slow and chronic exposure persistant.
	Toxicity -- Slightly moderate	Most toxic elements flushed out on outgoing tide. Some hydrocarbons could be adsorbed on clay particles causing chronic sublethal impacts and some mortality.		
Mixed-coarse	Physical -- Slight to moderate	Dissolved hydrocarbons could saturate tide pods on falling tide causing tainting or death.	Fast to moderate	Flushing would be rapid, but slower than exposed rock. Heavy coatings may remain in high intertidal.
	Toxicity -- Significant	Tarry residues may smother organisms. Subtidal rock surfaces unaffected.		
Mixed-fine	Physical -- Moderate	Oil mixed into surface sediments initially by wave action. Rate of burial quite high.	Slow	Residues can remain for long periods of time due to moderate to poor flushing.
	Toxicity -- Slightly moderate	Most toxic elements flushed out on outgoing tide. Some hydrocarbons could be adsorbed on clay particles causing chronic sublethal impacts and some mortality.		
Eelgrass	Physical -- Significant	Beds function as strainers and retainers of oil.	Moderate to slow	Beds located in sheltered bays, estuaries, and coves and along beaches where currents are slow and wave action moderate to irregular.
	Toxicity -- Slightly moderate	Hydrocarbons retained due to straining effect of plants causing chronic sublethal impacts and some mortality.		
Algae (kelp)	Physical -- Minor	Kelp traps oil in habitat.	Rapid	Beds found where there are strong currents.
	Toxicity -- Slightly moderate	Hydrocarbons trapped would cause chronic sublethal impacts and some mortality. Habitat most vulnerable from late June through October to November.		
Saltmarsh	Physical -- Significant	Smothering of vegetation and low flushing rate causing mortality.	Moderate to slow	Persistence of oil in sediments. Once oil removed, biological succession may be moderate since generally organisms reproduce and disperse fairly rapidly.
	Toxicity -- Significant	Toxic hydrocarbons would cause plant mortality.		
Open water	Minor	Impact on pelagic phytoplanton and zooplankton dependent on chance event of contacting floating slick. Fish may avoid spill. Not likely oil would accumulate in open water sediments to lethal or sublethal levels.	Fast	Rapid dispersion and degradation of oil.

[1] Washington State Department of Ecology, 1975; National Academy of Science, 1975; Hyland and Schneider, 1976; Hayes, 1977.

[2] Expected recovery would depend upon the severity of the oil spill. Fast recovery would be days to weeks; moderate recovery would be weeks to months; slow recovery would be months to years.

EFFECT OF OIL ON THE MARINE ECOSYSTEM



*Illustrations of sea creatures not drawn to scale

Benthos. Benthic animals (those which dwell on, or in the ocean floor) are susceptible to all five types of oil effects. They are particularly susceptible to alterations of their habitat, and in the case of intertidal benthos, very vulnerable to smothering by oil. Chan (1973) showed species such as acorn barnacles and limpets suffered high mortalities from smothering after a San Francisco spill. Juge (1971) found no burrowing organisms in heavily oiled sediments in the Santa Barbara channel. These animals probably died from direct toxicity.

Blumer, et al. (1970), Anderson, et al. (1973), Lee, et al. (1972) and others have shown that bivalve mollusks readily take up petroleum hydrocarbons. Marine bivalve mortalities have resulted in some cases. In others, where the clams, mussels, cockles, etc. have survived, the levels of petroleum hydrocarbons in their tissues remained so high that they were unsafe for human consumption for months to years. Animals can be repeatedly recontaminated by the oiled sediment. Lee, et al. (1972) showed that California mussels would eliminate more than 90 percent of the accumulated petroleum hydrocarbons within 2 weeks if moved to an uncontaminated environment.

Sublethal behavior effects are common in benthic animals. Taylor and Karinen (1977) showed exposure to crude oil can cause abnormal burrowing behavior in clams. Others have shown that crustaceans are particularly susceptible to behavioral effects from crude oil. Many species become motionless and simply sink to the bottom where they readily fall prey to other animals or are buried. Lobsters have been shown to adopt many aberrant behavior patterns when exposed to oil (Atema 1977). Since chemically mediated feeding, defensive, and reproductive behavior are vital to many bethic organisms it is possible that an oil spill could indirectly cause high mortalities.

Fishes. The effect of petroleum on fish ecology is not well known. Major spills and chronic low level pollution have their more severe impacts upon eggs, larvae, and fry. Adult fish are more resistant to stress than other life stages, as is true in other species. A notable exception may be anadromous fish, such as salmon, when they return to spawn.

The five most likely categories of impacts upon fish are briefly discussed below.

1) Eggs and larvae die in spawning or nursery areas due to coating or direct toxic effects (Hufford 1971, Mironov 1969). Others report that crude and bunker oils were toxic to fish eggs in concentrations of 1 ppm. Paten (1977) reported major behavioral abnormalities in larvae at levels of .001 ppm. These larvae simply sank to the bottom and remained inactive. This would almost certainly be fatal.

2) Adults could be killed. This is most likely to occur as a result of direct toxic effects or indirectly as a result of maladaptive behavior. For example, Morrow (1974) reported significant mortalities in coho and sockeye salmon exposed to crude oil concentrations of 500 ppm (at the water surface). He attributed the mortalities to changes in cell membrane permeability, especially in the gills. This in turn destroyed the fishes ability to regulate salt balance. Behavioral changes include: loss of equilibrium, inability to school, reduced swimming activity (Patten 1977) and avoidance (Rice 1973). Fish have elaborate feeding, breeding, defensive, and territorial behaviors. Many are chemically mediated and inappropriate responses could lead to mortalities and displacement.

3) These behavioral changes could prevent large numbers from reaching spawning grounds either from avoiding petroleum, or inability to smell subtle chemical directional cues. Anadromous fish could be most seriously effected by this.

4) Breeding populations could be lost due to contamination of spawning grounds, nursery areas or stream mouths. Stream mouths are avenues for anadramous fish. Marshes, which serve as nursery areas for many important species, are extremely vulnerable to oiling. Another area particularly susceptible to oil is the eel grass and estuary area. This habitat type, as well as kelp, is utilized extensively by Pacific herring for spawning and egg laying.

5) Reproductive success may be changed. Anchovies and striped bass have a rapid uptake of benzene into the ovaries. This markedly reduces the viability of resultant eggs and larvae.

6) Food species may be adversely affected or eliminated, causing shifts in predator populations.

Marine Mammals. This discussion is divided into two sections: 1) cetaceans (whales and dolphins), and 2) pinnipeds (seals and sea lions) and otters (sea and river).

Cetaceans. No documentation on the direct effect of oil on cetaceans is available (NOAA Tech. Mem. 1979) The memo states:

> Following the Santa Barbara oil blowout in 1969, some popular accounts appeared attributing small cetacean and gray whale strandings to the oil leakage. Brownell (1971) summarized details of cetacean stranding during that period and was unable to find evidence linking these strandings to oil pollution. In the analysis of the tissue samples from stranded gray whales, no evidence of excessive hydrocarbon loads was documented.
>
> Geraci and Smith (1977) speculate that stress produced by oil contamination may be an important effect on those cetaceans most sensitive to environmental changes, e.g., the harbor porpoise. Another potential danger to cetaceans is absorption of oil through the mucous membrane lining the blow hole beyond the nasal plug (Norris, USDI 1975). This area is always exposed to water and could become oiled during normal respiration. Eventually if penetration of the nares occurs a thin film of oil would cover much of the lungs and respiratory passages, resulting in inhibition of complete oxygen exchange, disruption of normal diving and feeding behavior, and eventual weakening the animal. Pneumonia and death could result (Norris USDI 1975).

Seals, Sea Lions, and Otters. These animals have high metabolic rates and highly developed means of insulation. The NOAA Technical Memorandum (1979) states: "Disruption of these mechanisms appears to be the immediate danger from oil pollution.—" California and Stellar (northern) sea lions, elephant seals, and harbor seals are insulated by a thick layer of blubber. Except for young pups (3-5 weeks) oil coating probably would not have a significant effect on insulation. LeBoeuf (1971) found no differences in mortality between oiled and unoiled elephant seal pups after the Santa Barbara oil spill. These pups had already been weaned and acquired a thick blubber layer. However, ingestion of petroleum or decreased food supplies could effect metabolism. Otters and fur seals have air trapped in the fur, providing primary insulation. When this fur is matted by oil contamination it loses its insulative quality, subjecting the animals to subnormal body temperatures. Keyon (1971) reported that sea otters died within hours after exposure to crude oil. There are no similar figures for fur seals. However, oiled fur seals are rarely seen, supporting the view that they probably die and sink. The young of all these species could suffer if their mothers were oiled while the pups were still nursing. This could result in oil being swallowed with milk. Studies of ringed seals have shown they rapidly absorb ingested crude oil. The NOAA Tech. Mem (1979) goes on to state "Low levels of hydrocarbons were found in body tissues and high levels were seen in bile and urine indicating rapid excretion."

Geraci and Smith (1976) showed liver and kidney damage in ringed seals in the field and laboratory. The damage did not appear significant, however. Seals, sea lions, and probably otters and cetaceans have eyes that can be readily damaged by oil. Nelson Smith (1973) reported "... after the Arrow spill, in Nova Scotia, young gray seals were found blundering about in woods, a half mile from shore, unable to find their way back because of oil around their eyes and nostrils ..." The NOAA Technical Memorandum (1979) and a number of other researchers have indicated that eye damage would be the most serious potential impact for pinnipeds.

Birds. Birds are one of the two groups most vulnerable to oil pollution. Unfortunately, bird populations do not have the recovery capacity of plankton. This section will discuss some of the effects of oil on birds, susceptibility of different types of birds, and impacts from past oil spills.

Oil causes the fine elements of feathers to adhere together, which breaks down their insulative and water repellant capacities (Bourne 1968, Clark 1969). Tuck (1960) claimed that a 1-inch patch of oil on the breast of a murre would destroy the insulating air pocket and cause death from exposure. When plumage is moderately oiled it becomes waterlogged. These factors cause birds to lose their buoyancy, ability to fly, and ability to dive (Erikson 1963, Chubb 1954). With the loss of insulation, the bird must increase its metabolism to maintain body temperature. However, because of its greatly reduced feeding efficiency this is usually impossible (McEwan and Kodink 1973).

In an attempt to clean oil off themselves, the birds ingest oil. Several researchers have stated that direct toxic effects of this ingested oil were an important factor in bird mortality. These authors showed ingestion of oil, in quantities comparable to what would be swallowed during preening, caused lipoid pneumonia, gastrointestinal irritation; liver malfunction, and adrenal cortical hyperplasia. Consumption of oil contaminated prey also leads to ingestion of oil. This was illustrated during the Amoco Cadiz spill when sea gulls were seen feeding on dead and dying intertidal organisms that were heavily oiled (NOAA/EPA Tech. Rep. 1978). The combined effects of cold, starvation (due to ineffective feeding), oil toxicity, disturbance, and presumably fright lead to acute stress upon birds. This reduces the birds' resistance to secondary infections and increases vulnerability to predation.

Egg laying has been temporarily stopped by birds fed small amounts of oil (Hartung 1967). Survival of embryos is greatly reduced when eggs are oiled by contaminated plumage. Diminished food supplies also can have a very serious impact upon birds. The behavior of many species increases their chances of becoming contaminated. For example, Bourne (1968) noted that guillemots took no notice of oil until they touched it. Then they exhibited their usual hazard avoidance behavior and dove. Diving, of course, resulted in the birds being totally oiled. In addition to species which react to alarm by diving, other behavior patterns that increase susceptibility are plunging and surface seizing feeding methods, surface roosting, night roosting, and flocking.

Estimating bird mortalities is difficult because most dead birds sink and many others are eaten. Jones, et al. (1970), Tanis and Marger-Bruyns (1968) estimated that 50 to 90 percent of oiled birds never reach shore. Other workers conducted experiments with dead birds and found only about 20 percent came ashore within 4 months. Considering the limitations upon determining bird mortalities table 8.4.3-20 is presented to show estimates of past impacts.

TABLE 8.4.3-20 OIL SPILLS AND BIRD MORTALITIES

Tanker	Date	Location of spill	Amount	Mortality
Amoco Cadiz	Mar 1978	France	216,000 tons crude, 4,000 ton bunker fuel	3,200 counted
Arrow	Feb 1970	Nova Scotia	11,379 tons Bunker C	12,800 birds, mostly chicks and eiders
Torrey Canyon	Mar 1967	England	100,000 tons Kuwait crude	40,000-100,000 birds
Gerd Maersk	Jan 1955	Elbe River	Unknown	500,000 birds of 19 common species, scoters
Two tankers	18 Jan 1971	San Francisco	800,000 gals crude	41,557 birds, western grebe 55%, scoters 23%, murres 10%
Tanker Duchess	1968	England	Unknown	50% of Tay Estuary population
Palva	1967	Finland	150 tons Russian crude oil	25% to 33% of local population killed

Source: Brown 1974; Goethe 1968; NOAA/EPA Special Report 1978

A tabular summary of the impacts upon marine habitats and marine biota is presented in tables 8.4.3-21 and 8.4.3-22.

TABLE 8.4.3-21 VULNERABILITY RANKING OF MARINE HABITATS

Physical Impact		Toxicity Impact
Salt Marsh	High Vulnerability	Mixed-coarse
Eelgrass beds		Solid rock
Silt		Salt marsh
Mixed-fine		Eelgrass beds
Mixed-coarse		Kelp beds
Sand		Mixed-fine
Solid rock		Mud
Kelp beds		Sand
Open water	Low Vulnerability	Open water

Source: Washington State Department of Ecology 1975

TABLE 8.4.3-22 VULNERABILITY RANKING OF MARINE BIOTA

Physical Impact		Toxicity Impact
Birds	High Vulnerability	Fishes
Shellfish (mollusk)		Annelids
Echinoderms		Molluses
Grasses		Echinoderms
Kelp		Birds
Crustaceans 1/		Mammals
Annelids		Crustaceans
Mammals 1/		Grasses
Fishes	Low Vulnerability	Kelp

Source: Washington State Department of Ecology 1975

1/ Barnacles and otters are highly susceptible to physical impact.

Specific Area Impacts

Impacts upon marine life will result from the construction and operation phases of the project. There would be no abandonment impacts unless the pipeline or berths were removed. Construction impacts would occur from direct burying and crushing, sedimentation, and possible resuspension of toxic materials.

For purposes of this discussion, potential oil spills will assume a spill size of 1,000 barrels and an arrival time onshore of no more than 2 days. The impacts described below would be worse in the case of a larger spill or less in the event of a smaller spill.

A 2-day arrival time is used because the average of all times to landfall was found to be 46.6 hours. It should be noted, with respect to the selection of a 1,000 barrel spill size, that the average spill size of all spills in Greater Puget Sound, between 1973 - 1976, was 4.9 barrels per spill. The average for 8 major U.S. ports during the same period was 217 barrels per spill (U.S. Coast Guard 1978). The calculated average spill size is 864 barrels for this proposal (OIW 1978). Chronic low level oil pollution from tanker operations is believed to present impacts only to the Low Point area. The impacts of this type of pollution in the other areas is expected to be negligible.

The following is a discussion of the anticipated impacts from the proposal in seven separate areas: 1) Outer coast from Cape Flattery to Grays Harbor, 2) Neah Bay to Low Point, 3) Low Point, 4) Agate Bay to Port Angeles, 5) Port Angeles, 6) Green Point, 7) Dungeness Spit and Bay.

Impacts from construction are considered to be negligible in all these areas, except Low Point. Abandonment impacts are expected to be negligible. Therefore, impacts would almost exclusively result during the operation phase of the proposal.

Outer Coast--Cape Flattery to Grays Harbor. No impacts from construction activities are anticipated. The closest oil spill would probably be just north of the Cape, at the entrance to the Strait of Juan de Fuca. Assuming medium ocean conditions, over 40 percent of the oil would evaporate within the first 24 hours. Moderate to major impacts still could occur at Tatoosh Island and the Flattery Rocks National Wildlife Refuge. Oiling the numerous offshore rocks and islets with their rich, rocky, intertidal communities would kill moderate numbers of these organisms. Fortunately, the normally rough water will help mitigate intertidal and shallow subtidal impacts by cleaning the rocky areas.

The most seriously impacted group would be the sea birds. Eight species have critical habitat in this area (Dept. of Ecology 1977). Major impacts could occur to the tufted puffin, common murre, pelagic cosmorant, Brandt's cormorant, pigeon guillemot, and glaucous winged gull. Minor to moderate impacts could occur to Thayers gull and the Black oyster catcher.

This section of coast is also designated as critical habitat for four marine mammals (Dept. of Ecology 1977). Impacts to Steller sea lions and harbor seals are expected to be minor. Because otters depend upon their fur for insulation any otters that contacted the oil would sustain major harm.

Impacts upon other marine life, such as the ocean perch, rockfish, ling cod, and sable fish could probably be minor to negligible.

South of the Cape and Tatoosh Island are important river, estuary, and salt marsh habitats at the Waatch and Sooes Rivers and Makkaw Bay. Estuaries and salt marsnes are extremely vulnerable to oiling. If a spill contacted these areas, impacts could be major and long lasting. Anadramous fish using these rivers could be forced away in an attempt to avoid the oil or confused by olfactory interference from the oil.

South of the Flattery Rocks National Wildlife Refuge is Quillayuite Needles National Wwildlife Refuge. Major impacts are expected on birds with critical habitats here, including western grebe, double crested cormorant, white winged scoter, surf scoter, and Cassin's auklet.

Oil reaching Grays Harbor would have additional time to evaporate and weather; impacts, therefore, should be less. If substantial amounts of oil did enter the

Harbor, even in a weathered state, major impacts would occur to tide flats and associated shellfish, to the marsh, to the shrimp and crab fisheries, the glaucous winged gull, common murre, and rhinoceros auklet. Other species with critical habitats in Grays Harbor would probably suffer moderate impacts. These include: English sole, starry flounder, green sturgeon, white sturgeon, American shad, black brandt, mallard, pintail, canvas back, red knot, and dunlin.

A spill occurring at Cape Flattery or in the Strait during late fall/winter would probably not reach the areas just described due to northward moving currents.

Neah Bay to Low Point. The most vulnerable invertebrate resources in this area probably would be the intertidal clam beds at Neah Bay, the estuarine clams and crabs at Pysht River and other invertebrates associated with these two habitats. Impacts are expected to be major, with clams suffering more than crabs. The marsh, lagoon, and sandflats inhabitants at the Pysht River estuary could sustain major impacts. Impacts to fish, both bottom-dwelling and migratory species, would be minor. Harbor seals at Waadah Island in Neah Bay probably would experience moderate impacts. Disabling eye injuries could be sustained by some of the seals. Impacts upon waterfowl at Waadah Island and Pysht River estuary probably would be moderate for most species. Some species, such as scoters, would suffer major impacts because their behavior increases their chances of being oiled.

Low Point. Construction activities will cause physical destruction of the kelp bed if the pipeline is buried under the kelp. Complete recovery would be expected within 1 to 2 years.

The kelp bed off Low Point will help prevent oil from reaching the shore. Although the small crustaceans in the surface layers of the kelp would suffer major impacts their recovery would be expected to be rapid. The kelp itself is resistant to oil. A 1,000-barrel spill should have only minor impacts. Chronic low level pollution from the Low Point facility could have minor impacts. An oil spill added to these chronic effects probably would result in moderate impacts to the kelp bed and its associated life.

Migratory fish using the Lyre River could suffer minor to moderate population declines during construction activities. Chronic pollution could result in minor declines throughout the life of the project. A 1,000-barrel spill occurring during migration could have major impacts. At other times effects probably would be minor.

Harbor seals live at Low Point. Construction activities could displace the eals resulting in moderate to major impacts. Ongoing human activity and chronic pollution probably would have minor impacts. A 1,000-barrel spill could have major impacts. A few harbor seals probably would be killed, and up to 40 percent of the population displaced for the life of the project.

No large concentrations of birds are found at Low Point. The American wigeon is identified by the Department of Ecology (1977) as one of the most common birds here. This duck's habits have led Gardner (1978) to place it in the rarely oiled category. Expected impacts, therefore, would be minor. Three other species, the bufflehead, common golden-eye, and pigeon guillemot are classified by Gardner (1978) as often oiled. They would be expected to suffer major impacts.

Agate Bay to Port Angeles. River otters with critical habitat in Crescent Bay and off Tongue Point are one of the most sensitive species in this area--a spill would have major impact. Chronic low level pollution, even at this distance, could have moderate impacts.

Birds common to this area which could sustain major impacts are the greater scaup, spotted sandpiper, and dunlin. Impacts to the black oyster catcher would probably be minor. Northern bald eagles have a critical habitat in this area; impacts could range from minor to moderate.

Pacific halibut would experience minor impacts.

The Ewha River estuary includes salt marsh, shallow channels, and sand flats--all important habitat to many invertebrates, fishes, and birds. These habitats and most of their associated species could suffer major impacts. Clams that survived the initial oiling could be continually recontaminated from oil within the mud for several years.

Port Angeles/Ediz Hook. A variety of habitats are found here, including sand, mud, mixed fine, open water, estuary, eelgrass beds and kelp beds. Construction impacts and chronic low level pollution from the Low Point tanker terminal should have no effect upon biological resources. An oil spill, of course, could. A 1,000-barrel spill could cause major impacts to clams and other organisms in the mud, mixed fine, estuary, and eelgrass bed habitats. Kelp bed impacts would be minor. Crabs could suffer less than some bottom species because of their mobility; impacts could be minor to moderate. Impacts to fish in these habitats would vary with season and species. Surf smelt would suffer major impacts if a spill occurred during spawning season; at other times impacts could be moderate. Pacific halibut and most other fishes could be expected to sustain minor to moderate impacts. Harbor seals and river otters could suffer major impacts. Bird species here are anticipated to experience moderate effects.

Green Point. Huge beds of hard shell and geoduck clams occur off Green Point. The geoduck beds comprise 16 percent of all the geoduck clams in the Strait and Sound. An oil spill could kill many of these clams and contaminate the survivors for extended periods. Fortunately, frequent rough water off Green Point could speed the natural cleansing process. Anticipated impacts upon most other species here are minor. Those species directly or indirectly dependent upon the clam beds could sustain more serious impacts. This area is listed as an important habitat for the red necked grebe. Because of this bird's behavior, a 1,000-barrel oil spill could have a major impact.

Dungeness Spit and Dungeness Bay. Dungeness Spit and Bay are probably the most important biologically of all the segments. Many species here are highly susceptible to oil pollution.

The extensive sand-mud flats, marsh and eelgrass beds, and all dependent flora and fauna could suffer major impacts. Recovery times for the mud flats and marsh could be many years. Eelgrass beds form the basis of a complex ecosystem, and is a vital food chain link for many species including mallards, American widgeon, and canvas-backs (these three species, plus black brandt and pintail, are all listed by the Department of Ecology as having critical habitat here). Eelgrass is vulnerable to low level oil pollution as well as large spills. Small amounts of oil increase eelgrass vulnerability to attack by parasites. Goodwin (1978) and Goodwin and Shaul (1978) rank Dungeness Spit as the most important hard shell clam bed and second most important geoduck bed in Puget Sound. An oil spill could have major impact upon these clams. Pacific oysters are cultured here and could experience major impacts. Crabs could suffer moderate to major impacts while impacts on octopus are expected to be moderate.

Surf smelt and Pacific halibut have a critical habitat here; major to moderate impacts are expected for these two species. Other fishes in this area probably would sustain minor impacts.

Harbor seals and river otters have critical habitat here, and both would suffer major impacts. In addition to the 5 bird species listed as having critical habitat, 16 others have important habitats between here and Sequim Bay. Of this total, at least 12 birdspecies could be expected to suffer major impacts.

Dungeness Spit and Bay are biologically important supporting an unusual and highly productive association of organisms. There is a strong possibility that if a 1,000 barrel or larger, oil spill hit this area that its biological character would be substantially altered for many years.

TERRESTRIAL VEGETATION

Construction Phase

Approximately 300 acres of vegetation will be cleared from the Low Point site during construction. While clearing this area would remove only a small portion of the total vegetation in the area, local impacts may be critical. The most obvious economic impact would be loss of timber production. The onshore storage facility would be cleared of all vegetation for the life of the project.

Wherever land is cleared, the adjacent vegetation is exposed to wind damage. Western hemlock and Sitka spruce have comparatively shallow root systems, increasing susceptibility. Vegetation killed or weakened by construction related activities (either directly or indirectly) and not cleaned up, would provide breeding grounds for insect pests, parasites, and disease organisms.

During construction, several factors will contribute to an increased danger of forest fire: 1) use of flammable materials, 2) the operation of construction equipment, and 3) the presence of careless smokers.

A number of toxic substances such as fuels, antifreeze, x-ray developing fluids and rust inhibitors will be used during the construction period. It is possible that a certain amount of these toxics will be spilled. The long range effects of these types of spills are unknown.

The clearing of vegetation would expose more ground surface to sunlight. Those species requiring shade would be eliminated, at least temporarily. The effect of this change in species composition means that the area actually impacted by clearing of the onshore storage area is somewhat larger than the area which is physically cleared.

If care is not taken during construction to ensure that topsoil is stockpiled for future replacement, reegetation problems could be encountered upon completion of the project.

No federally proposed threatened or endangered plant species are known to occur in the Low Point area.

Operation Phase

Major impacts on terrestrial vegetation would result from oil spilled during tanker operation in the Strait of Juan De Fuca, operation of marine terminal unloading facilities, and use of onshore storage facilities. The following discussion of the impacts of oil on plants and habitats was taken directly from a report prepared by Dames and Moore on an earlier TMC proposal to tranship offshore crude oil from Cherry Point, Washington, to refineries in the northern tier states, printed in December 1977. This discussion does not attempt to assess the probability of a spill. Oil spill risk analysis is examined in section 8.4.2 for onshore and port facilities.

Little is known about the effects of crude or refined oils on terrestrial ecosystems. The few records of oil spills or experimental applications on plant communities suggest that thick, woody stems are fairly well protected from oil damage. Investigation of spills made along a military pipeline in Alaska shows that only woody plants survived crude oil spills (Rickard and Deneka 1972). There is some indication that roots, unlike leaves, are less susceptible to oil damage since they have no stomatal openings and are surrounded by soil and water (Belsky 1975, Baker 1970).

The effect of oil on terrestrial vegetation depends on the oil's molecular structure and size, whether fractions are aliphatic or aromatic, the degree of saturation, and possibly whether it is a paraffin- or asphalt-based. Compounds with small molecules are usually highly volatile and may evaporate before damaging plants (Texas A&M 1972). Crude products with large molecular structures do not penetrate plant tissue, but cause physical damage by adhering to the leaves (Baker 1969).

Baker (1971a) conducted several surveys of marshes affected by the 1968 Milford Haven incident. As a result of field observations, she identified five major factors as important in assessing oil's effect on marine vegetation.

1. Amount of oil
2. Type of oil
3. Cleaning treatment
4. Time of year
5. Plant species

Baker concluded that the primary effect of oil is formation of a film that is difficult to wash off the plant. The amount of oil spilled appears immaterial to the individual plant since once a plant is thoroughly oiled, death is almost certain.

Carr (1919) reported that small amounts of crude oil in sandy soil stimulated soybean growth, but plants died when crude oil concentration reached 4 percent. In studies conducted in Oklahoma, Plice (1948) found that reduced production of sorghum, cotton, soybeans, and field beans occurred after relatively light crude oil applications (as small as 0.1 percent by weight of oil in the topsoil). Subsequent crops showed similar response to the crude oil.

Annuals and seedlings are most susceptible to crude oil damage. Exposure to crude kills shoots by smothering, physical breakage, and reduction of chlorophyll production. Initial rapid loss of green color is followed by a loss of turgor and collapse (Hellebust et al. 1975). Where surface contact does not occur, survival is better, but chlorophyll loss may be noted within 2 weeks after oiling.

The active growing season, May through August, is probably the most critical, as characteristically warmer temperatures may decrease oil viscosity allowing it to penetrate plant surfaces more easily. Studies by Baker (1971b) revealed reduced flowering for plants oiled while flower buds were developing. Perennial plants, especially those which store food in their roots, appear to survive oil damage better than plants without underground storage. Hellebust et al. (1975) noted extensive killing of the shoots of *Carex aquatilis*, an emergent hydrophyte, due to surface contact when oiled in July. Plant parts below the water level appeared to survive well, allowing considerable recovery by the next growing season. *Carex rostrata*, growing in a drier habitat showed a reduction of 60 percent for roots and rhizomes 1 year after treatment.

Evergreens, plants with generally thick, waxy cuticles that restrict penetration of toxic compounds, show the least damage in the first year following a spill. Trees that survive the first year after either winter or summer spills frequently winterkill.

Woody plants are quite susceptible to oilspill damage, but it is usually longer before all spill effects become evident (Hutchinson and Freedman 1975). Storage tissue appears to be a significant survival factor.

Seed germination and seedling development are important to rehabilitation following an oil spill, especially for annuals. Some oiling effects may be physical rather than chemical as experiments have shown oiled seeds will germinate after washing. Oil probably blocks water and oxygen uptake, thereby preventing germination in seeds (Baker 1971b).

The actual susceptibility of a given plant species to oil varies. However, Baker (1971c) has developed an artificial system ranking plants according to susceptibility as follows:

1. Very sensitive: shallow rooting with no or small food reserves, quickly killed by a single spill
2. Susceptible: shrubby perennials with exposed branch ends which are badly damaged by oil.
3. Intermediate: perennials which usually recover from a spill of up to four light experimental oilings but decline rapidly if further oiled.
4. Resistant: perennials with large food reserves. Most die back in winter but have survived 8 to 12 experimental oilings.
5. Very resistant: perennials which have an additional resistance at the cellular level compared to those in Group 4.

This system was developed as a result of field observations and experimental oilings conducted in the marshes of England. However, some of the genera discussed by Baker in her various papers have representative species in North America."

Facilities constructed at the 300-acre onshore storage site will not fill the void left by trees removed during construction. The surrounding forest will continue to be subjected to wind damage, as discussed in the construction phase, for the life of the project.

This species composition of vegetation around the periphery of the facility will be altered due to increased sunlight reaching the ground, and subsequent increase in soil temperature. Shade tolerant species will give way to shade intolerant species, forming a zone of shrubby vegetation in the first few feet of forest which differs from the existing zone.

No federally proposed threatened or endangered plant species are known to occur in the Low Point area.

Abandonment Phase

Abandonment of moorings and submarine pipelines should cause no additional impacts to terrestrial vegetation. Onshore storage facilities are to be dismantled and removed, the area graded and recontoured, drainages reestablished, and grass and herbaceous species seeded to prevent soil erosion and help establish natural succession. Since seeds of native species generally are not available commercially, non-natives will likely be used in revegetation. This may cause competition problems between natives and non-natives in the early stages of succession, however eventual restoration of native tree and shrub species will occur.

Problems may be encountered in trying to establish vegetation on the site due to 1) soil compaction, 2) oil or other toxic residues present in the soil, 3) lack of adequate topsoil, and 4) possible presence of impermeable material left behind which was used to construct containment dikes around the storage tanks.

No impacts are expected on federally proposed species of threatened or endangered plants.

TERRESTRIAL WILDLIFE

Construction impacts on wildlife can be of three basic types: habitat loss, habitat alteration, and disturbance. Habitat loss impacts wildlife by causing a decrease in food and cover. Habitat alteration would include such impacts as changing the vegetative community type and species composition from, for example, dense forest to grasslands. Disturbance from noise and human activity can affect wildlife on the site and in the surrounding area. The degree of impact from the disturbance is related to the season; for example, mammal breeding seasons and bird nesting seasons are most sensitive. Periods of greatest sensitivity to disturbance are illustrated in figure 3.2-1. Impacts may be short term (lasting a year or less or for only one generation of the species) or long term (lasting longer than one year or for more than one generation).

Construction, Operation, and Abandonment Phases

Construction of onshore storage facilities would result in a loss of approximately 300 acres of wildlife habitat. However, removal of this habitat should not significantly affect terrestrial wildlife on a regional scale. Water-oriented bird populations should not be significantly affected, as Low Point is not in an area of known high concentrations (NTPC 1978). Game animals and furbearers would be displaced from the site. The success of displaced animals in establishing new territories depends on whether adjacent habitats can support a larger population. Disturbance may cause big game and sensitive species to avoid suitable habitat near the site. Oil spills should be contained on-site and not be a hazard to nearby terrestrial wildlife. If an oil spill escaped containment, nearby wildlife habitat could be polluted, and wildlife in the area could be contaminated with oil. Wildlife avoidance of the area will probably occur until vegetation is reestablished after project abandonment.

Endangered Species

No rare, threatened, or endangered species are known to inhabit the site. The nearest known bald eagles nest is located approximately 2 miles west of Low Point. Others are known about 5 miles east of the site, in the headlands of Crescent Bay, and 10 miles east at Observatory Point. Human activity at a distance of approximately 1,000 feet is tolerated by 98 percent of bald eagles; if closer eagles will interrupt feeding or roosting (Grubb 1976). Construction, operation, or abandonment should have no significant effect on this sensitive species.

CULTURAL RESOURCES

Archaeological and Historical Resources

Construction Phase

Two documented prehistoric sites at Low Point would be affected during construction. These two sites would be recovered prior to construction (TMC 1979). Since the majority of the southern coastline of the Strait of Juan de Fuca is recoginized as traditional Clallam Indian territory, there is a possibility that unrecorded cultural resources may be discovered or damaged because of the proposed project.

Operation Phase

An oil spill, and subsequent cleanup activities, could potentially affect archaeological sites at nearby beaches. In a worst-case situation a previously unknown site could be hit by a spill and destroyed by cleanup operations.

Abandonment Phase

The expected effects of abandonment and dismantling of the port facilities would largely depend upon construction phase impacts and the adequacy of pre-construction resource recovery programs. If resources were recovered or destroyed by construction, no additional impacts would be anticipated during abandonment.

Paleontological Resources

No fossils are currently known to exist at the site. Construction and abandonment of the proposed project could possibly reveal previously unknown sites, and damage might result. The operation and abandonment phases of the proposed project should have no effect upon paleontological resources.

VISUAL RESOURCES

Evaluations of the visual sensitivity of the proposed project sites are derived from a modified version of the Bureau of Land Management's visual resource management system, discussed in chapter 2. BLM's visual contrast rating system is used to estimate impacts. This system evaluates the suitability of the project for the environmental setting. The form, line, color, and texture of the structures and alterations are contrasted to those of the existing landforms and vegetation (table 3.2-20).

Construction Phase

The panoramic view of the Low Point cove and Strait of Juan de Fuca would be dominated by several construction vessels as they install the two moorings over a 3 to 4 month period. This concentration of vessels would be a short-term visual intrusion to residents and recreationists in the Lyre River Campground area and to vessel traffic in the Strait. Impacts of much greater significance would be realized during construction of the onshore storage facility. The removal of trees and excavation of the storage area tank, plus the dredging and trenching for the submarine pipelines across the beach area and over the bluffs would be visible to local residents, recreationists, and off-shore viewers. The 90-foot clear-cut right-of-way extending from the beach, up the 125-foot sloping bluff, to the storage site would be seen in the foreground by beach recreationists and in the middle background by vessel travelers. The right-of-way swath cut through dense forest cover would cause highly contrasting form, line, color and texture changes to the onshore storage site. This would be a severe visual impact. Further visual impacts would occur if excess width is needed to traverse the unstable sloping bluff.

The area would be clear-cut, gravelled, and fenced, with eight storage tanks 40 feet high by 300 feet diameter, plus support equipment and buildings, and would be partially exposed to view from vessels in the Strait. The onshore storage facility will be a significant visual intrusion when viewed from local residences and state highway 112.

Operation Phase

Visual concerns during project operation would focus on the single point mooring facilities.

The size of two moored tankers, plus two or three others enroute or refueling, would contribute substantially to the visual dominance of the project facilities. The moored tankers would dominate the view from vessels in the Strait of Juan de Fuca. No significant visual impact to shore-line viewers is anticipated.

Any oil spills not immediately boomed and cleaned up would be likely to wash up on the beaches and rocky shoreline. A major oil spill could severely degrade the scenic quality of the beaches, shoreline, and water structures.

Abandonment Phase

Removal of the moorages and onshore storage facilities would improve the visual quality of the area. No long-term impact would result from removal of the port and onshore storage facilities.

No further impact would result if the submarine pipelines were left in place. The impact of removing the pipeline from the bluff could be more severe than installing it. It would not be possible to restore the original form of the bluff.

LAND USE

Construction Phase

Construction of the onshore storage facilities would cause direct impacts on existing land use at the site. Approximately 300 acres of land would be converted from predominantly forest and pastureland, with some residential use, to an industrial facilities site. Three residences housing 10 or 12 people at the site would have to be removed.

No significant indirect land use impacts have been identified. It is unlikely that the construction work force and activities would cause existing land uses to change significantly.

Construction would conflict with nearby land uses chiefly through nuisance impacts such as noise, dust, visual disharmony, and increased traffic. During construction of the port facilities, these nuisance impacts would be felt most strongly in the rural residential area to the east of the site. The cumulative impacts of these nuisances could be of significant annoyance for up to 2 years.

The onshore storage facility site is not currently zoned for any specific use, although it is designated in the county comprehensive plan as a potential living area. The text of the Clallam County Comprehensive Plan (Clallam County 1967) does not define the designation "potential living area." Since there is no definition nor any language to preclude industrial development in undesignated portions of potential living areas, the onshore storage facilities would apparently be consistent and in compliance with the county's comprehensive plan.

The proposed port and onshore storage facilities at Low Point would be inconsistent with a 1976 amendment to the Clallam County Comprehensive Plan (Ordinance No. 70 of 1976). This ordinance states that oil ports and related facilities are prohibited in all areas under jurisdicition of the plan.

If the northern boundary of the Low Point site if considered a shoreline cliff, the construction of the submarine pipeline would not conform with the county's shoreline master program that protects shoreline cliffs in conservancy and natural environments.

Operation Phase

The direct impacts to existing land uses caused by conversion of the site to industrial use would continue through the operation and abandonment phases.

It is anticipated that project operation would not cause significant indirect land use changes. Existing residential and commercial land should be sufficient for the anticipated population and services increase associated with the proposed project.

During operation of the port facilities, impacts to land use would occur only in the event of an oil spill, explosion, or fire. Significant areas which might be impacted include the Pacific Rim and proposed West Coast National Parks in British Columbia; the Makah and Lower Elwha Reservations on the Olympic Peninsula; and land uses adjacent to the shoreline. Only very large spills would be likely to reach the shoreline in concentrations sufficient to be a health or safety hazard and to require intensive cleanup efforts disruptive to shoreline land uses. The estimated frequency of such a spill occurring from 205 tanker calls per year is one spill every 168 years. A large spill seems unlikely to occur during the life of the proposal. Should such a spill occur, cleanup response would be limited due to the lack of rail facilities west of Port Angeles, and the relatively low standard of state highway 112. Travel time for cleanup equipment from Port Angeles to Neah Bay would be about 2 hours.

The land uses most susceptible to impact from an oil spill, fire or explosion occurring near the berthing facility are described earlier in this section. Small spills would likely be contained. Assuming that a spill of more than 100 barrels would be required to impact adjoining land uses, the probability of a spill of that size ocurring (205 tanker calls per year) is estimated to be one spill every 7.7 years. This probability would be one fire every 45.8 years and one explosion every 112.3 years.

At the onshore storage facility site, the risk of an oil spill, fire, or explosion significantly impacting adjoining residential and agricultural land uses is similarly remote. Only in the case of a multiple failure (tank plus containment dike rupture) could oil spread outside the boundaries of the storage facility or be likely to affect domestic or agricultural water supplies. If an average of 50 percent of the four million barrel storage capacity were used the estimated frequency for spills exceeding 1,000 barrels is one in 263 years. The incidence of fire loss over $10,000 is estimated at one every 110 years. The expected occurrence of explosions has not been estimated.

A "worst case" explosion might cause moderate structural damage to storage facilities to a distance of 1,500 feet and cause human injuries to a distance of 1,000 feet. The existing forest buffer might reduce the area exposed to damage.

Abandonment Phase

The process of abandonment should not cause significant land use impacts. Abandonment would cause nuisance impacts similar to those of construction. The area should be suitable for other uses when the facilities are removed.

TRANSPORTATION AND UTILITY NETWORKS

This section considers impacts that might occur to inland water transport, roads and highways, railways, airways, and electric transmission and supply.

Inland Waterways

Construction, Operation and Abandonment Phases

Because Low Point currently has no shipping activity, construction activities would not significantly affect marine vessel traffic. The moorages would be located about 2.5 nautical miles south of the center of the inbound shipping lane. About 205 tanker calls per year, with a comparable number of fuel barges, would be generated by the project. During operation, the area surrounding the moorages would be unavailable for use by other boats. In addition, tankers approaching and leaving the moorages would disrupt other boat traffic in the area. Abandonment of the port facilities is not expected to significantly affect marine vessel traffic.

Railroads

Construction, Operation and Abandonment Phases

No rail service exists near the site and none is planned. Rail service currently terminates in Port Angeles. No impacts are expected.

Roads and Highways

Construction Phase

The greatest potential for transportation impacts would exist during construction when the largest amount of land-based traffic would be generated. Up to 400 construction employees would be commuting to Low Point during the 2-month of construction period. Using the worst-case assumption of one employee per car, 800 vehicle trips/day could be generated. Allowing for an annual growth of 3.5 percent in nonproject traffic, total daily traffic on state highway 112 during peak traffic hours would be about 1,205. Highway capacity is 1,675 vehicles/hour, yielding a vehicle to capacity ratio of about 0.7. Traffic impacts would be aggravated by slower-moving construction-related trucks entering and leaving the site. Because of the nature of the road (two lanes with sharp curves) and of the traffic (logging trucks, cars, and campers with trailers), construction vehicles could cause significant increases in congestion for short periods of time, especially during the tourist season. The additional traffic on Highway 112 would increase the need for road maintenance and repair.

Operation Phase

Thirty-four employees would operate the project facilities; truck deliveries would be minimal. This would increase traffic, State Highway 112 should not be affected. No significant traffic impacts would occur as a result of operation of the proposed facilities at Low Point.

Abandonment Phase

Removal of the project facilities would cause temporary traffic increases similar in magnitude to those caused by construction, but of shorter duration.

Air Transport

Construction, Operation and Abandonment Phases

The airport nearest the Low Point site is the William R. Fairchild International Airport at Port Angeles, 18 miles to the east. No impacts are expected.

Electric Transmission

Construction Phase

Construction of the port facilities would require electrical power. The Clallam County Public Utility District would supply electric power to the site. Increased electric loads due to construction needs would not be significant. An emergency diesel generator would provide backup power for essential services.

Operation Phase

Once in operation, the port facility would exert significant loads on the Clallam County utility system (table 8.4.3-23). Clallam County Public Utility District has indicated that future power supplies after 1983 are in doubt. The District proposes to provide power to the port facility, however, the source and cost of power after 1983 is uncertain (McInnis 1979).

TABLE 8.4.3-23 ELECTRICAL DEMAND FOR LOW POINT PORT FACILITIES

Facility 1/	Peak Demand (Megawatts)	Load Factor (Percent)	Monthly Megawatt (Hours)	Annual Megawatt (Hours)
Onshore Storage Facility	1.7	40	490	5,880
Pump Station #1	9.8	100	7,056	84,672
Total	11.5		7,546	90,552

1/ EPA's legal obligation to serve the utilities' firm energy requirement ends and an allocation system begins on July 1, 1983. If current forecasts hold, Clallam County Public Utility District would be about 7 1/2 megawatts over its allocation. Clallam County has contracted with the Washington Water Public Power Supply System (WPPSS) for about 17 megawatts. Power is not scheduled to be available from WPPSS until the latter part of 1985 and 1986, if then. Clallam County Public Utility District should have sufficient power if TMC's 11.5 MW demand is not added. Adding TMC's demand leads to a forecasted deficit of 2.0 megawatts in the utility district's firm energy supply.

If the utility contracts with TMC to supply firm energy, and critical hydro conditions occur, the utilitt might not be able to meet their other contractural obligations and be forced to curtail service to industrial customers. This would result in worker layoffs and lost revenues for the industry(s) affected. If power to TMC was temporarily interrupted, additional tankers might queue in the harbor, possibly impacting marine traffic described previously. The magnitude of the impact would depend on the severity and duration of the power shortage. The risk of these occurrences represents a potentially significant impact. In addition, TMC's load would further limit local utilities' already limited ability to serve additional loads. For comparison, within the Pacific Northwest during 1977, one average megawatt served just under 600 residential customers; 1975-76 actual load for the Crown Zellerbach pulp and paper mill at Port Angeles was 22 megawatts.

Abandonment Phase

Abandonment of the project should not cause any significant impacts to electrical supplies or transmission networks. The electrical energy used by the project would then be available for other uses.

RECREATION

Construction Phase

Construction noise would decrease the desirability of recreational use of the Lyre River campground and day use area, which are within 1 mile of the construction sites, facing the moorage and submarine line. Other recreation activities in the area are minor and would not be impacted significantly by construction of the port and onshore storage facilities.

Operation Phase

Normal operation of the proposed port and onshore storage facilities would not significantly affect recreational use of the area. Due to the lack of facilities and distance from major urban centers, Low Point does not experience heavy recreational use of its shoreline. An in-transit spill off Low Point could contaminate marine resources and reduce user desirability of areas between Cape Hattery and Angeles Point. There are few shoreline parks and public accesses along this part of the Strait. The beaches at Crescent Bay, reported to be the most scenic beaches along the Strait, could be affected by oil contamination. Annual use of the bay beaches is unknown; however, the nearby Salt Creek Recreation area at Tongue Point reported 159,000 visits in 1978. Short term losses of fishing opportunity in the onshore areas may occur depending on the season and severity of the spill.

Recreational boats and gear would be fouled by the oil spill, and deter recreational boating and sport fishing during of the cleanup.

Abandonment Phase

Impacts would be similar to those occurring during construction.

ECONOMIC CONDITIONS

Fisheries

Construction Phase

Construction activity would cause moderate impacts on shellfish harvests in the vicinity of the port and submarine pipelines for 3 to 10 years. Shellfish populations which might be affected are small, and the impact on fisheries values would not be significant.

Operation Phase

Chronic pollution in the vicinity of the port area would affect shellfish and bottomfish harvests to a minor degree. Any loss of salmon production in the Lyre River would also have a minor effect on salmon harvests.

Losses from oil spills would be more substantial, particularly in the event of a large spill over 1,000 barrels. Such losses would depend on the severity of resource damage which in turn would be dependent on where and how the spill took place, the size of the spill, the season of occurrence, species present, and success of containment and clean-up efforts. Because of the number of variables, the range of conditions for each, and the lack of available resource information, these losses have not been quantified. An oil spill would cause substantial mortalities to shellfish in the vicinty of occurrence. Losses would occur over a several year period and would affect both sport and commerical fisheries. The value of bottomfish harvests could be reduced if the fish became tainted. Salmon would be unlikely to suffer much impact from a marine spill, although a spill affecting the mouth of a spawning stream during spawning periods or while smolts were leaving the stream could substantially reduce production for the year class affected. Boat and gear clean-up costs and loss of fishing time would be incurred by fishermen. Claims for direct economic losses could be made against the parties responsible for an oil spill. Some losses, nevertheless, would be borne by commercial and sports fishermen, fish processors, sporting goods stores, marinas, and others.

Impacts on Canadian fisheries have not been addressed.

Abandonment Phase

No impacts from abandonment of the project have been identified.

Population

Construction Phase

Population gains due to construction activity are shown in table 8.4.3-24. The derivation of the estimates is shown in the table footnotes and in the text under Industry and Employment. These estimates omit population gains attributable to the construction inspection and management work force, and the unemployed job seekers. The inspection and management work force would probably represent an additional 5 to 10 percent of the construction work force, and a similar addition to the transient population. The number of job seekers is unknown. According to the Washington Department of Employment Security, an influx of job seekers is almost inevitable, although "it would be difficult to believe many of them would stay in the Port Angeles area if no work were obtained" (Piott 1978).

The maximum population increase shown in the table results from a 1-month overlap of scheduled work on the submarine pipeline at the port with the assumed work schedule for the land pipeline in Clallam County. This peak might not occur, or it might be extended over a longer period. The impact in either case is considered significant. Conditions of crowding could result from the temporary population increase and the acquisition of goods and services could be less convenient.

Operation Phase

The resident population would be increased by not more than 200 to 300 persons. This impact would not be significant.

Abandonment Phase

No impacts have been identified from project abandonment.

Industry and Employment

Construction Phase

The construction cost estimates were compared with NTPC cost estimates on a unit cost basis as shown in table 8.4.3-25. The comparison indicated higher unit cost estimates for TMC facilities with the exception of the land pipeline which is substantially lower. The higher estimates for the submarine pipelines and the marine crossings are probably influenced by the greater importance of mobilization and demobilizaiton costs in the estimates because of the shorter pipeline lengths involved.

Estimates of the construcion work force in Clallam County shown in table 8.4.3-24 were based on information furnished by the applicant. Estimates of the work force distribution for the port and submarine pipelines were obtained by dividing the total man-months required for each facility by the number of months scheduled. The man-months required to construct the onshore storage facilities were calculated as two-thirds of those estimated for the NTPC facilities which would be 50 percent larger. This total was distributed approximately uniformly over the site preparation and construction periods. The land pipeline work force was assumed to be at full strength of 334 workers throughout the construction period and to progress at a uniform rate from the terminal to the Canadian border. The land pipeline work force during construction in Clallam and Jefferson Counties was assumed to be lodged 85 percent in Clalla County and 15 percent in Jefferson County. Pump station work force estimates were furnished by the applicant. Pump station workers were assumed to lodge in the county in which the work site was located.

During construction, total employment of workers lodged or residing in Clallam County would average about 700 over tne 14-month construction period. Employment of local workers average about 65 in construction activities, and 190 more in jobs generated in other industries by these activities. The local employment estimates are based on the assumption that union job placements would come equally from throughout their jurisdiction areas. Much higher levels of local employment might result from a program by the applicant to employ local workers. Unemployment would probably be increased temporarily by an influx of job seekers, but it is unlikely that many job seekers, would stay without employment. The temporary gain in local employment would be significant.

Local governments and community services might experience minor and temporary loss of staff to higher paying construction jobs.

Higher wage scales in construction activities would put upward pressure on non-union wages, especially in the less skilled services sector. Higher wages and greater job opportunities would be viewed as a beneficial impact by local workers. Businesses dependent on local labor would experience higher operating costs, which should be offset by increased business activity. Higher wage levels induced by construction activity would not likely be sustained after the construction period, but would return to pre-existing relationships with other areas.

TABLE 8.4.3-24 CONSTRUCTION WORK FORCE, EMPLOYMENT, AND TRANSIENT POPULATION, CLALLAM COUNTY

Item	Year 1												Year 2							
	J 1	F 2	M 3	A 4	M 5	J 6	J 7	A 8	S 9	O 10	N 11	D 12	J 1	F 2	M 3	A 4	M 5	J 6	Total	Average
Facility Workforce:																				
Marine Terminal						105	105	105	105	105	105	105	105	105	105				1,050	--
Terminal Pipeline								280	280	280	280	280	280	270					1,950	--
Onshore storage		83	160	160	160	160	160	160	160	160	160	160	160	160	160				2,163	--
Land Pipeline1/		42	42	284	284	284	284	226											1,446	--
Pump Station		5	5	5	10	23	23	23	23	23	10	5	3						158	--
Total construction workforce2/		130	207	449	454	572	572	794	568	568	555	550	548	535	265				6,767	483
Local construction workforce3/		17	28	60	61	77	77	106	76	76	74	74	73	72	35				906	65
Induced employment4/		63	100	217	219	276	276	384	274	274	268	266	265	258	128				3,268	233
Total employment		193	307	666	673	848	848	1,178	842	842	823	816	813	793	393				10,035	717
Local employment5/		69	109	236	239	301	301	418	299	299	292	290	289	282	140				3,564	255
Transient population6/		282	451	980	995	1,246	1,246	1,731	1,237	1,237	1,210	1,198	1,194	1,164	576				14,747	1,053

1/85 percent of land pipeline work force (334 workers) in Clallam and Jefferson Counties.
2/omits construction management and inspection work force.
3/calculated at 13.4 percent of work force as derived from analysis for Northern Tier proposal.
4/calculated at 48.3 percent of construction work force as derived from analysis for Northern Tier proposal.
5/calculated at 35.5 percent of total employment (construction work force plus induced employment) as derived from analysis for Northern Tier proposal.
6/calculated at 2.278 times transient work force (total employment minus local employment) as derived from Northern Tier analysis.

Tourist activity in Clallam County would be adversely affected by the crowded conditions and lack of accommodations caused by construction activity. Transient lodgings which are normally near full capacity during the summer would be partially occupied by transient workers, and the difficulty in finding accommodations would reduce tourist visits. The reduced availability of facilities would also affect recreational fishing, ferry traffic, and visits to Olympic National Park. The reduction in tourist business would be more than offset by increased business from construction-related activities for most businesses. However, the ferry operator, marinas and other businesses dependent on recreational fishing and tourist trade at places remote from construction activity around the Olympic loop highway would be adversely impacted. The magnitude of these impacts has not been determined.

TABLE 8.4.3-25 CONSTRUCTION COST COMPARISON OF TMC AND NTPC

	Construction Costs			Length	Unit	Ratio
	Stated	Adjusted	Size	(Miles)	Cost	(TM/NT)
Trans Mountain:						
SPM, etc.	$ 28,600	$ 31,284 1/			$ —	$ —
Terminal pipeline	17,100	14,416 1/	48"	5.0	60.07	1.38
Onshore storage	45,800		4,000mmb	---	11.45	1.30
Land pipeline	91,400	82,221 2/	30"	142.5	19.23	.63
Construction only	34,900		30"	142.5	8.16	.72
Marine crossings	17,100		30"	5.5	103.64	1.34
Northern Tier:						
Marine terminal	$ 58,917				$ —	
Terminal pipeline	28,021		48"	13.4	43.56	
Onshore storage	52,941		6,000mmb	---	8.82	
Land pipeline	131,209 3/		42"	102.4	30.51	
Construction only	48,678 3/		42"	102.4	11.32	
Marine crossings	73,137		42"4/	23.4 4/	77.25 4/	

1/ Cost of metering facilities transferred from pipeline to SPM facilities for comparability.
2/ Omits pump stations.
3/ Estimated by pro rata adjustment of earlier detailed cost estimates for revisions of summary data.
4/ Unit cost per inch-mile includes allowance for 6 miles of 36" pipeline.

Oil spills in the marine environment would affect commercial and recreational fishing as discussed above. The damages from an oil spill to aesthetic and recreational values would have a minor effect on tourism. Claims for direct economic losses resulting from an oil spill could be made against the responsible parties. Damages from a catastrophic spill such as the total loss of a large vessel could exceed the financial resources of the responsible parties, however, the increase in risk over the existing risk associated with such an event is considered too small to be economically significant.

Fire or explosion in the vicinity of the SPM's could cause substantial damage to vessels, mooring facilities, equipment and personnel within a radius of 1,600 feet (OIW 1979). This is not considered a significant environmental impact.

Abandonment Phase

No impacts from abandonment of the project have been identified.

Income

Construction Phase

Income generated during the construction period was estiated by multiplying the total man-months of employment shown in table 8.4.3-24 by the amount of income per man-month as derived from the NTPC analysis for Clallam County. Additional personal income would amount to about $27,900,000. This would represent a significant positive impact on the economic welfare of some Clallam County residents, but a negative impact on others. The prices of some goods and services, particularly restaurants, bars, and rental housing, might be temporarily increased, and individuals not benefiting from the increased income would suffer temporary losses in their economic welfare.

Land values in the vicinity of the onshore storage facility might be temporarily depressed by nuisance factors associated with construction activity.

Operation Phase

Personal income generated during operation has not been estimated, but is considered unlikely to represent a significant impact.

Operation power requirements would increase average costs for the Clallam County P.U.D. because the cost of additional supplies is higher than that of existing supplies. Unless the power costs aid by the applicant equalled the costs of the additional supplies, other utility customers would bear a portion of the increased costs. The increased costs could be significant.

The value of residential properties in close proximity to the storage facilities would be adversely affected. Shoreline property values could be temporarily adversely affected by a major oil spill.

Abandonment Phase

No impacts from abandonment of the project have been identified.

Fiscal Conditions

Construction Phase

County and city governments in Clallam County would receive an estimated $577,000 in sales tax revenues during the construction period. Sales tax imposed on the value of construction (excluding engineering and construction management, and environmental studies) would amount to about $533,000. A minor portion of this amount would accrue to the City of Port Angeles. Tax revenues from local consumption expenditures and other expenditures induced by construction activities would be about $44,000, and would probably accrue mainly to Port Angeles.

Construction activities would cause increased needs for governmental services. School districts would probably experience significant increases in unreimbursed expenditures. County and City governments would have increased expenditures for road maintenance and for fire and police personnel. The impact on these governments could be significant if increased expenditures substantially exceeded the increased revenues of any separate government.

Operation Phase

The assessed value of taxabale property in Clallam County would be increased by about $90.8 million in the first year of project operation. This estimate is based on the construciton costs of the facilities as shown in table 8.4.3-25. The assessed value of the facilities in subsequent years would be determined on an income valuation basis and would be subject to depreciation. Even though the average assessed value over the project life might be only half the initial value, the increase in total assessed value for the county is considered significant.

Property tax collections in the initial year based on the average levy of 15.49 mills in 1978 would amount to $1.4 million. Amounts accuring to individual governments and taxing districts have not been estimated.

Additional expenditures of local governments would be minor.

Abandonment Phase

The loss of project property from the property tax base would be significant.

SOCIAL CONDITIONS

Population

Construction Phase

The total manpower requirements for construction of the moorages and onshore pipeline in Clallam County are listed in table 8.4.3-24a. The maximum number of construction workers would be needed during the 15th and 16th months of the 2-year project.

During the peak period of construction, 400 personnel would be employed within Clallam County--78 local and 322 nonlocal employees. In-migration of non-local, direct and indirect workers and their families represent a population increase of about 982 during peak construction and 624 for average construction.

Operation Phase

Approximately 36 employees would be required for operation and maintenance of the Low Point facilities (including the pipeline segment within Clallam County). An additional 11 indirect jobs would be created in Clallam County. Approximately 30 percent (4 jobs) of these indirect jobs would be held by people who move to the area. In addition, approximately 40 new jobs could be generated through project-related expeditures in Clallam County (TMC 1978).

Assuming that (1) 40 nonlocal workers moved to Clallam County, (2) 75 percent of these would have families, and (3) the average family size is 3.6 then the resident population would increase by 108 persons in Clallam County as a result of operation. This represents less than 0.5 percent increase over the projected 1980 population of Clallam County. The impact of this increase should not be significant.

Abandonment Phase

The abandonment of the port and onshore storage facilities, and the 36 jobs discussed earlier, would cause a loss of about 108 persons from the population. The abandonment crew, probably less than 100 persons, would likely enter after operating personnel had left the area. These impacts should not be significant.

Infrastructure

Construction Phase

The number of housing or lodging units required to accommodate the maximum construction-related population (including the nonlocal, direct, and indirect employment) would be 211 family units and 220 single units, a total of 431 units. The average demand for housing during construction would be 304 units. Maximum demand would exist for a short time during peak construction. It is likely that some workers not accompanied by families would share accommodations.

During the summer tourist season, rental units would be in short supply. Construction workers would compete with tourists and vacationers for motel space and camping facilities in the area. Adequate housing would exist from October through May.

The escalation of rental rates could create a hardship on the resident population. The large retirement population living on fixed incomes would be adversely affected by short-term rent hikes. Rental rates would decline within several months as housing demand decreased.

The water and sewage systems would not be significantly impacted during construction of the project. Both systems have a capacity for at least 40 percent over current use, or about 7,000 people.

The solid waste disposal sites should not be strained. Although capacity estimates are not available at this time the largest site should be able to accomodate the county's solid waste for about 50 more years (Clallam County Governmental Conference 1977).

TABLE 8.4.3-24a MANPOWER REQUIREMENTS: CONSTRUCTION AND OPERATION OF THE LOW POINT PORT, ONSHORE STORAGE FACILITIES, AND PIPELINE IN CLALLAM COUNTY 1/

Facility	Construction Man Months																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total Man-Months in Clallam County	Total Man-2/ Months Outside Clallam County	Total Man-Months	Maintenance & Operations Personnel
Tanker Unloading (includes moorages and submerged pipeline)	10	10	10	10	10	10	10	10	10	10	100	100	100	100	150	150	150	105	50	50	1,200	1,800	3,000	NA6/
Onshore Storage	50	100	100	100	200	200	200	200	200	200	200	200	250	250	250	250	50	50	50	50	3,150	1,950	5,100	343/
Pipeline in Clallam County (includes 2 pump stations)	110	244	344	354	46	46	46	46	46	20	10	5	—	—	—	—	—	—	—	—	1,318	NA 4/	NA 5/	2
Totals	170	354	454	464	256	256	256	256	256	130	310	306	350	350	400	400	200	200	100	100	5,668	3,750	8,100	36

Source: TMC 1979

1/ Manpower requirements supplied by TMC (Samson 1979).

2/ Labor force required for fabrication of facilities components in areas outside of Clallam county.

3/ Includes maintenance and operation personnel for both the onshore storage facilities and the moorages.

4/ NA means not applicable. Refer to table 8.4.3-__ for total pipeline construction personnel.

5/ Refer to table 8.4.3-__ regarding total pipeline labor force statistics.

6/ These manpower requirements are included in the onshore storage facilities estimate.

Based on the population increase associated with construction of the facilities, about 140 school-age children would enroll in area schools. If these students are evenly distributed among grades, grades K-6 in Port Angeles District #121 will not have adequate classroom space. Classrooms in grades 7-12 will not be significantly impacted. If the anticipated school expansions in Sequim are completed as scheduled, that district will not be adversely impacted. Additional expenditures by the districts will be required to provide transportation, furniture, textbooks, and other instructional materials for the incoming students.

Table 8.4.3-26 summarizes the hospital bed needs to be generated by the construction crew in addition to present needs. Based on this assessment of needs, the population growth associated with construction and operation of the proposal would have no significant impact on existing hospital facilities. On the average, only one additional bed per day will be required by TMC's construction-related population, and 49 vacant beds will be available. TMC's operation-related population will not generate any measureable increase in bed needs.

The ratio of primary care physicians to residents served indicated a current shortage of such physicians in Jefferson County. If the number of primary care physicians does not increase, this shortage will become more acute as populations increase, with or without construction of the TMC (see table 8.4.3-27). In Clallam County, assuming no increase in the number of primary care physicians, the level of primary health care service will remain above the standard through 1982, irrespective of TMC project-related population growth.

Security at the onshore storage facilities will be the responsibility of TMC. The facility will have been designed to incorporate safety and security features, such as external lighting and perimeter fences. In addition, TMC personnel will be trained, under a contingency plan, to participate in pertinent emergency procedures. The plan calls for close liaison with local law enforcement agencies (TMC 1978).

Existing law enforcement agencies in the study area are described in section 8.4.2. Potential impacts on these agencies from TMC-related population growth have been estimated by calculating the police-to-resident ratio both with and without TMC, assuming no growth of the staff of these agencies. This information is presented in table 8.4.3-28. All agencies, except the Jefferson County Sheriff's Department and the Sequim Police Department (for 1980 only), show current and future police-to-resident ratios below national averages even without the population growth caused by the TMC. The influx of TMC-related newcomers will have an adverse effect on these existing staff inadequacies, as shown by the figures in the table 8.4.3-28.

The above nalysis compares agency staff to service area population ratios for the individual municipal and county law enforcement agencies. While the peak construction population influx will have minor effects on staff requirements of the individual agencies, the total peak construction-related population will generate a short-term need for about two additional officers throughout the area (TMC 1979). This conclusion is based on the national staffing averages of 1.5 to 1.8 officers per thousand residents. In addition, traffic generated by construction workers and materials deliveries to construction sites may require additional traffic police.

TABLE 8.4.3-26 HOSPITAL BED NEED PROJECTION FOR CLALLAM AND JEFFERSON COUNTIES

A. Current use rate = $\dfrac{\text{patient days per year (1977) 1/}}{\text{service area population (1977) 2/}} = \dfrac{27{,}175}{53{,}700}$ = 0.543 days per year per resident

B. Average bed need per day = $\dfrac{\text{current use rate x projected population}}{365}$

1980 without TMC = 86 beds per day
1980 with TMC = 87 beds per day
1982 without TMC = 90 beds per day
1982 with TMC = 90 beds per day

C. Bed need = $\dfrac{\text{average bed need per day}}{0.80}$

1980 without TMC = 108 beds
1980 with TMC = 109 beds
1982 without TMC = 113 beds
1982 with TMC = 113 beds

D. Number of licensed general care beds = 158

E. Beds available per day = licensed beds - bed need

1980 without TMC = 50
1980 with TMC = 49
1982 without TMC = 45
1982 with TMC = 45

1/ For the three hospitals (Olympic Memorial, Jefferson General, and Forks Community) in the two counties.

2/ Total population of Clallam and Jefferson Counties. 1980 projections "with project" based on peak construction period. Hill-Burton recommended occupancy standard of 80%; actual 1977 occupancy rates in the three hospitals were considerably lower. For all three hospitals (assumes no expansion from present capacity).

TABLE 8.4.3-27 RATIO OF PRIMARY CARE PHYSICANS 1/ TO RESIDENTS IN CLALLAM AND JEFFERSON COUNTIES 2/

County	1977	1980		1982	
		Without Project	With Project	Without Project	With Project
Clallam	1:1840	1:2005	1:2051	1:2093	1:2106
Jefferson	1:3750	1:4516	1:4524	3/	3/

Source: TMC 1979

1/ Primary care physicians include general practitioners, family practice doctors, obstetricians/gynecologists; pediatricians and general internists. A ratio of 1:2000 is considered adequate and anything less than 1:3500 is considered inadequate.

2/ Calculations are based on number of doctors in 1977.

3/ Jefferson County is not in the regional study area for TMC operational population growth.

TABLE 8.4.3-28 POLICE PROTECTION IN PORT AND ONSHORE STORAGE AREA
Number of full-time officers per thousand residents served 1/
Based on 1978 staffing figures (1977 for Clallam County Sheriff's Department)

Area	1978	1980		1982	
		Without Project	With Project 2/	Without Project	With Project 2/
Port Angeles Police Department	1.18	1.10	1.08	1.06	1.05
Sequim Police Department	2.00	1.83	2.77	1.75	1.74
Clallam County Sheriff's Department	0.87	0.80	0.79	0.77	0.77
Jefferson County Sheriff's Department	2.30	2.14	2.14	+	+

Source: Clallam County Governmental Conference 1977

1/ Residents in municipality for municipal police departments, residents in unincorporated areas for county sheriff's deparments.

2/ Ratio based on peak population due to TMC.

National Averages for number of officers per thousand residents served are as follows: Towns under 10,000 population - 1.8; towns between 10,000 and 25,000 population - 1.6; county sheriff's department - 1.5 (FBI 1976).

TMC will provide fire protection systems at the moorages and onshore storage facilities. Firefighting and detection apparatus represents the primary fire protection systems, and if necessary, would be supplemented by services available from the Port Angeles Fire Department and other agencies. The final design and procedures for the facilities would be developed in cooperation with the Port Angeles Fire Department, Clallam County Fire Protection District 3, the U.S. Coast Guard, and the Seattle Fire Department.

The likelihood and potential impact of fire and explosion at both the moorages and onshore storage facilities are addressed early in this section. While the calculated probabilities of major fires at these facilites are low, such occurrences may result in calls for assistance from municipal fire protection agencies. Analysis of the impacts of potential fire protection demands generated by the moorages and onshore storage facilities on municipal fire protection agencies (the Port Angeles Fire Department, Clallam County Fire Protection District 3, and other fire protection districts and minicipal departments in Clallam County) is beyond the scope of this report. TMC has planned to provide on-site fire protection systems.

Estimates indicate the increase in future fires expected as a result of TMC-related population growth would increase the need for additional firefighting personnel by one to two firefighters.

Operation Phase

Housing needs associated with the 20-year operation phase would not have a significant impact. Approximately 95 homes would be purchased during this period, which should be available on the Port Angeles market.

No significant effects will be felt on the water, sewage, or solid waste systems in the county.

During the operation phase, about 60 additional children will be enrolled in the three school districts. This would result in an average 0.5 percent increase over projected 1980 and 1982 enrollments, causing minimal impacts.

There will be no impacts on medical facilities or physican-to-resident ratios.

The influx of newcomers during operation will have a minor adverse impact on existing police protection inadequacies in Port Angeles and Clallam County. No additional fire protection personnel would be needed.

Abandonment Stage

Assuming continued growth in the local economy as indicated by projections, the sale of homes by operating personnel and others leaving the area would not significantly affect housing conditions.

Abandonment of the project will result in an approximate 0.5 percent decline in school enrollment.

There will be no impacts on medical facilities and services, police and fire protection, or the water, sewage, and solid waste systems.

SOCIAL WELL-BEING AND QUALITY OF LIFE

Construction Phase

During construction of the proposed project, there would be a slight increase in county population totals. It is not known what effect construction of the proposed project would have on the unemployment rate. But, since local employment opportunities are limited (about 78 local employees would be needed), the impact would be insignificant.

Operation Phase

Operation of the project would have no significant impacts on social well-being as indicated in this discussion. There would be no significant impacts except from a worst possible case situation of massive oil spill, fire, or explosion.

Construction of the proposed project would have minimal impacts on the social well-being of the Makah and Lower Elwha tribal peoples. However, the operation phase would involve adverse impacts to their fishing enterprises.

Operation of the moorages, with associated increases in tanker traffic, electric power demand, and possible of oil spills, would compete for the same types of resources needed for fishing activities. The tribal groups would be forced to monitor the operation, a commitment of time and money. A worst possible case situation could have serious effects on the fish harvest. While long-term consequences probably would be insignificant, short-term impacts on income and employment would be adverse and significant.

The project would have adverse impacts on the quality of life of Native Americans. Tribal members dislike the prospect of an oil port and onshore storage facilities near their reservations. Indians, with strong cultural ties to tribe and reservation, are far less likely to move to another region.

Implementation of the project would adversely impact future reservation developments towards increased local control, economic independence, and local employment opportunities.

Abandonment Phase

No significant impacts would be expected.

PIPELINE SYSTEM

PIPELINE OIL SPILL RISK ANALYSIS

The Oceanographic Institute of Washington (1978a,b,c) has determined a spill occurrence rate of 220 spills per year for every 100,000 pipeline miles. The average spill size reported was 622 barrels.

The use of mileage as an exposure variable is especially useful for estimating spill risk. However, the risk in a pipeline corridor where more than one line is being operated (as would be the case in portions of the TMC proposal) may be overstated, as it has not been demonstrated that spill occurrence is proportional to the number of lines. Corrosion is assumed to be one of the major causes of oil spills (along with exposure to unrelated activities, such as ditch digging). Therefore, newer lines should not be expected to display the historical rate of spillage.

The OIW has determined a lower risk to underwater lines. A spill rate of 84 per year for every 100,000 miles (with an average spill size of 115 barrels) has been applied to submarine portions of the proposed TMC pipeline.

Pipeline Spill Occurrence

The above figures, applied to the existing pipeline network in the Greater Puget Sound area, yielded an estimated spill frequency of one every 1.19 years (see table 8.4.3-29).

TABLE 8.4.3-29 ESTIMATED PIPELINE FREQUENCY MAGNITUDES FOR EXISTING PIPELINE IN GREATER PUGET SOUND (For Spills $\geq$ 2.4 Barrels)

Spill Size (barrels)	Spill Frequency and Uncertainties 1/ (Years per Spill) one spill every:
2.4 - 10	3.2 years (1.5 - XX)
10.1 - 100	2.3 years (1.2 - XX)
101 - 1,000	9.5 years (4.7 - XX)
1,001 - 10,000	45.8 years (21.9 - XX)
10,001 - 100,000	396 years (190 - XX)
Spill _ 2.4	1.19 years (.57 - XX)

Source: OIW 1978c

1/ Figures in parentheses are based on the 95% confidence limits of the derived historical pipeline spill rate, and were calculated by assuming that the variance of each spill magnitude category was equal to the variance of the data for all pipeline spills. Upper limits are unpredictable and indicated by the XX.

Valves would be placed along the pipeline route to minimize potential line drainage in the event of a spill. The maximum potential spill estimate is based upon complete line drainage between a possible rupture and either the nearest valve closing the line, or elevation changes which prevent oil drainage. During intentional drainage of existing lines, it has been found that only about 50 percent of the oil can be cleared out of the line without some type of pumping because of topographical undulations. Thus, the spill estimates will tend to be conservative, assuming the spill detection systems are correctly utilized.

The pipeline route was divided into nine sectors, generally corresponding to drainage basins along the corridor. The results of spill frequency projections are given in table 8.4.3-30. The resultant spill risk for the entire line from Low Point to Sumas is 0.315 spills per year (i.e. one spill every 3.2 years).

TABLE 8.4.3-30 FREQUENCIES FOR PIPELINE SPILLS

Approximate Pipeline Mile	Traverse	Length (miles)	Spill 1/ Frequency (years) one every:
0-14	Olympic Central	14	32.47
14-32	Port Angeles	18	25.25
32-52	Olympic Northeast	20	22.73
52.59	West Sound	7	6.49
59-64	Admiralty Inlet	5	238.10
64-70	Whidbey Island	6	75.76
70-73	Saratoga Passage	3	400.00
73-83	Camano Island	10	45.45
83-102	Skagit River	19	23.92
102-122.5	Samish River	20.5	22.17
122.5-139.5	Nooksack Basin	17	26.74
139.5-148	Sumas River	8.5	53.48

Source: TMC 1979

1/ Rates: Land spill rates = 0.0022 spills/mile/year
Submarine spill rates= 0.00084 spills/mile/year

The maximum credible spill which might occur in the drainage area of major water crossings is given in table 8.4.3-31, along with the estimated frequency of occurrence.

TABLE 8.4.3-31 SPILL EXPOSURES OF MAJOR DRAINAGE AREAS

Crossing	Line Drainage (feet) (feet)	Spill Frequency (years) once every:	Maximum Spill (barrels)
Elwha River	5,000	455	7,000
Dungeness River	6,000	909	7,600
Salmon River	6,000	455	7,600
Admiralty Inlet	20,000	84	20,000
Saratoga Passage	10,000	212	11,000
Samish River	15,000	25	15,000
Samish Lake	11,000	54	12,000
Whatcom Creek	11,000	91	12,000
Squalicum	15,000	152	15,000
Ten Mile Creek	10,000	91	11,000
Noosack River	11,000	114	12,000
Sumas River	12,000	54	13,000

Source: TCM 1979

The distribution of various onshore pipeline spill sizes is given in table 8.4.3.-32.

TABLE 8.4.3-32 SPILL SIZE OCCURRENCES--PIPELINE

Size 1/ (barrels)	Probability 2/ of occurrence
2 - 100	55.6
100 - 200	12.6
200 - 500	10.1
500 - 1,000	7.9
1,000 - 2,000	6.1
2,000 - 5,000	4.5
5,000 -10,000	3.2

Source: TMC 1979

1/ Average spill size: 622 bbl.

2/ This table shows the probability of occurrence of various size spills. For example, in the event of a spill, there is a 55.6 percent probability that the spill size will be 2 to 100 barrels. Similarly, if there is a spill, the probability of the spill being between 5,000 and 10,000 barrels is 3.2 percent.

Mainline station fires and explosions resulting in damage over $1,000, reported in the American Petroleum Institute's "Reported Fire Losses in the Petroleum Industry" from 1972 through 1976, are listed in table 8.4.3-33. Over half of the fires caused less than $10,000 damage, but the average loss per fire was about $62,000 (OIW 1979).

TABLE 8.4.3-33 HISTORICAL DAMAGE FROM PIPELINE STATION FIRES 1/

Fire Loss ($)	Number	Percentage of Total Number
1,000 to 10,000	28	53%
10,000 to 100,000	17	32%
100,000 to 500,000	7	13%
over 500,000	1	2%
Total	53	100%

Source: OIW 1978

1/ For fires causing damage over $1,000

The frequency of a fire and explosion at the Fairmont and Burlington pump station, calculated from the historical fire and explosion rate is one fire and explosion every 286 years (OIW 1979; Dames and Moore 1979). TMC has calculated the frequency for fire losses at the two stations along the pipeline corridor to be (in 1975 dollars):

once every:

$ 1,000 -- 143 years
$ 10,000 -- 304 years
$100,000 -- 1,190 years
$500,000 -- 7,143 years

The probability of fire or explosion loss during a 20-year period are shown in table 8.4.3-34.

TABLE 8.4.3-34 PROBABILITY OF FIRE LOSS AT PUMP STATIONS 2 AND 3 OVER A 20-YEAR PERIOD

	Fire Loss $1,000 (percent)	Fire Loss $100,000 (percent)
One fire	12.2	2.06
More than one fire	0.9	0.02

Source: TMC 1979

AIR QUALITY

Construction Phase

Construction of the pump stations and pipeline would result in temporary, localized emissions from the construction equipment engines. Localized fugitive dust also would be generated during the construction phase. The temporary impacts as construction spreads passed through an area would not be significant.

Operation Phase

During the operation phase, emissions from the electric pump stations and pipeline system would be negligible; no significant air quality impacts would be anticipated.

Abandonment Phase

Emissions during the abandonment phase would be similar to those during construction. Impacts would be localized, of short duration, with no significant impact no air quality.

NOISE

Construction Phase

Construction of the pump stations would cause increased noise levels for 12 months. Significant noise sources would include construction equipment and welding machines. The noise would cause temporary annoyance to nearby rural residences.

Increased noise levels also would result from pipeline construction the duration of which would depend upon the rate at which construction proceeded. Highest expected noise levels would range from about 50 dBA at 4,000 feet to 70 dBA at less than 500 feet from the construction site. Homes in Port Angeles and Bellingham would be affected by significant noise levels, as would some rural residences. The noise would last for only a few weeks, at most.

Operation Phase

The principle source of noise in the pipeline system would be the electrically driven pumps at the pump stations. The maximum noise level at 100 feet would be about 64 dBA (TMC 1979).

Abandonment Phase

Noise impacts generated from abandonment procedures would be similar to those of construction.

TOPOGRAPHY AND GEOLOGY

Topography

Construction Phase

Topographic impacts along the proposed pipeline route would be minor and occur mainly during construction. The effects, largely of a visual nature (see Visual Resources section), would be most pronounced along coastal bluffs such as Bush Point and in areas of moderate to steep terrain such as the Olympic Mountains (pipeline mile 33 to 47) and between Chuckanut and Lookout Mountains (pipeline mile 114 to 125). Based on a working width of about 80 feet, landscape changes would average between 10 and 25 acres/mile, depending upon terrain. One of the three pump stations would be on the onshore storage site, and the acreage that would be graded and levelled for the others is about 1.15 acres each.

Operation Phase

Normal operation of the pipeline system would have no identified impacts on the topography.

Abandonment Phase

Abandonment and removal of the pipeline would result in impacts similar to those during construction. In addition, topography would be altered at borrow pits where soil would be obtained for backfilling the trench.

Physical Geology

Construction Phase

The structure and physical characteristics of geologic materials in the pipeline trench will be altered. This is considered a minor impact. Assuming the trench is 6 feet deep and 4 feet wide, approximately 4,700 cubic yards of material per mile would be disturbed. In the areas where bedrock would be encountered, blasting probably would be required. The blasted material would not generally be suitable for backfill, and borrow material would be substituted.

Operation Phase

Operation of the pipeline would have no identified impact on the geology.

Abandonment Phase

Except for blasting removal of the pipeline would result in impacts similar to those of construction. About 960 cubic yards per mile trench backfill material would be obtained locally to compensate for the volume of the removed pipeline.

Geologic Hazards

Construction Phase

Pipeline trench excavation and/or blasting could create unstable slopes or reactivate old slides. Slope movements could range from small rock falls involving only a few hundred cubic feet of material, to mass movements involving several thousand cubic yards of material covering several acres of land.

The slides most likely occur in areas of steep terrain or existing slope instability. Significant slope movement is likely to occur near Blyn (pipeline mile 42), the coastal bluffs (particularly Bush Point, pipeline mile 65), and Lookout-Chuckanut Mountains (pipeline miles 114 to 125). Slides could result in the destruction of equipment or loss of life, as well as modification of terrain and vegetation.

No other geologic hazards are anticipated.

Operation Phase

Seismic-related activities (surface fault rupture, ground shaking, liquefaction), slope instability, and outburst flooding are the geologic hazards considered capable of producing significant or critical impacts to the pipeline system during operations.

Surface Fault Rupture Fault movement across the pipeline could break it, resulting in an oil spill of up to 20,000 barrels. However, as no active surface faults would be crossed, the potential for such movement would be minor.

An assessment of impacts that could be caused by eight surface faults is not possible, as they have not been positively identified as faults. The faults are mentioned to draw attention to the need for more detailed study of these potential hazards. The Map Addendum depicts these features.

Ground Shaking. Strong ground shaking in the vicinity of the pipeline system could cause the pipeline or a mainline station to fail, resulting in an oil spill of up to 20,000 barrels. While final design criteria have not been established, TMC has indicated the pipeline system would be designed to withstand the seismic events that could reasonably be expected to occur during the life of the project.

Liquefaction. Liquefaction of sediment directly beneath the pipeline could rupture the line, which could result in an oil spill. Potential areas of liquefaction are shown in the Map Addendum.

Slope Instability. Slope instability could bend, rupture, or remove support from the pipeline or mainline stations. Slope failure could also block or damage access roads, necessitating additional maintenance and repair. While the pipeline would cross few areas exhibiting slope instability, the few that it would cross could result in significant impacts to the pipeline. The Map Addendum depicts these areas.

Outburst Flooding. In areas with relatively high outburst flooding potential, scour and streambank erosion could expose the pipe to potential rupture. While outburst floods are possible throughout the proposed pipeline route, only the Elwha River (pipeline mile 16) has potential for significant impacts. This hazard is due largely to the Elwha Dam, located 2 miles upstream. When the dam is repaired, this hazard will be largely removed.

Abandonment Phase

Seismicity, Slope Instability, Outburst Flooding. These potential hazards would have the same impacts on the pipeline system as during operation. However, because the pipeline would be filled with wastewater instead of oil, the environmental consequences of a line rupture would be much smaller.

Mineral Resources

Consruction Phase

Pipeline construction would not interfere with recovery of sand and gravel deposits in the Puget Sound area, as this resource is very abundant and widespread. No hardrock mines are crossed by the proposed route.

Operation Phase

Operation of the pipeline system would not impact on mineral resources because aggregate is a very abundant and widespread resource in the region, and no hardrock mines are crossed.

Abandonment Phase

After removal of the pipe, fill material amounting to about 960 cubic yards per mile would be needed for backfill along the pipeline. This material would come from borrow pits along the route.

SOILS

Construction Phase

Almost 1,500 acres would be disturbed and exposed to erosion at some point during construction of the pipeline. The soil structure would be destroyed during excavation of the pipeline trench. Topsoils would be segregated from the subsoils during trench excavation, but some mixing would occur despite efforts to replace soil layers in their original sequence. The remainder of the right-of-way would experience only topsoil disturbance in most cases.

Water erosion along the proposed pipeline route could vary from less than 2 tons per acre per year on nearly level gravelly loam soils to more than 40 tons on steep soils. However, it cannot be assumed that all of the soil eroded within the right-of-way would be deposited as sediment in nearby streams. Measures designed to reduce or retard runoff would retain most of the displaced topsoil within the right-of-way. Fugitive dust losses would average 225 pounds (about 2 cubic feet) per acre.

Almost 1,500 acres, including about 270 acres of prime agricultural land, would be removed from production during construction.

Construction eqipment would cause some soil compaction, especially on wet, poorly drained, fine-textured soils. The resulting loss of productivity would be partially mitigated by discing, ripping, and plowing. Except for a small (less than 5 percent), short-term decrease in crop yields, the effects of compaction would not be noticed.

Operation Phase

Following restoration of the right-of-way, normal pipeline operation would have negligible impact on the soil. Except for a few areas of problem soils, revegetation would be complete or well underway by the second growing season following construction, and erosion losses would decrease to near normal. If terrestrial oil spills or leaks occur, soils would be contaminated. Impacts on the soil would vary according to size of the spill, soil characteristics, type of ground cover, topography, and oil viscosity. A more detailed discussion of terrestrial oil spills can be found in section 3.2.1.

Abandonment Phase

Removal of the pipeline would cause impacts similar to those of construction. Impacts associated with obtaining backfill material also would occur.

More details are available in section 3.2.5.

AQUATIC RESOURCES

This section addresses freshwater resources.

Physical Components

Construction Phase

Pipeline construction would temporarily decrease surface water quality by increasing suspended sediment and cloudiness during clearing, trenching, pipe installation, and backfilling operations. Not all sediment eroded from the cleared right-of-way would reach surface water; the amount would depend on rainfall intensity, duration, and frequency, soil type, the length and angle of the slope adjacent to the streambank, and the effectiveness of erosion control measures. Suspended sediments would be carried varying distances downstream before settlement, depending on stream velocity, slope, and size of sediment particles. Generally, smaller particles are carried farther downstream. Most streams would eventually flush themselves and return to preconstruction quality.

Construction machinery fuel or other chemicals could be accidentally spilled into surface water drainages. The effect on water quality would depend on the type and quantity of the substances spilled and stream characteristics.

Groundwater flow would not be significantly affected by construction, although some pipeline sections may lie below the water table. During construction, draining the trench in areas of seasonally high water tables would be required. The displaced groundwater could be pumped into adjacent drainages where it would recharge the aquifer, or be mixed with other surface water.

Water for hydrostatic testing of the pipeline would be obtained from local streams or rivers when available; this would temporarily decrease stream flow. The water would be transferred from test section to test section unless local restrictions require the return of the water to the source. After testing is completed, the water would be treated and returned to the source or adjacent watershed, as required. Discharge of the test water to local streams would temporarily increase stream flows but should not significantly impact water quality. No impact on ground water would be expected from hydrostatic testing.

Operation Phase

Under normal operation, only minor impacts from pipeline maintenance would be anticipated. The most significant impact of pipeline operation would result from a leak or rupture degrading the surface and groundwater quality. The severity of impact on stream water would depend on the type and amount of oil spilled, time before oil containment, topography of the area, volume of stream flow, and season. The severity of impact to ground water would depend on location and volume of the oil leak, depth of the groundwater below the surface, water table gradient, and permeability of subsurface materials. See the discussion on Oil Spill Risk Analysis, earlier in this section.

Abandonment Phase

Abandonment procedures require removal of oil from the pipeline by flushing with water to remove oil residue and combustible gases. Holding ponds would be required to separate oil from wastewater before treatment and discharge into streams and rivers.

Removing the pipeline would cause impacts similar to those of construction. Where the pipeline was not removed (such as major stream crossings), impacts from decomposition of the pipeline would be very slow, lasting decades after abandonment. No major change in stream quality would be anticipated. Fuel oil spills could occur during the abandonment activities, degrading water quality.

Biological Components

Construction Phase

The pipeline would be buried in the beds of 43 salmon streams, and in several additional smaller creeks and sloughs possibly used by migratory trout, resident trout, or other resident fish species. Pipeline construction would cause slight increases in sedimentation and would remove streamside vegetation, decreasing cover and terrestrial food sources for fish.

Excessive sedimentation during construction might reduce salmon and trout populations, especially if substantial volumes of sediment reach the streams and are deposited during vulnerable growth stages. The degree of impact would depend on several factors including the time and place of sediment inputs relative to the presence of salmon and trout eggs young fry in the stream gravel. These stages are most vulnerable to sedimentation. Sediments could smother eggs or young fry in the gravel for a short distance downstream from the disturbed area. Recently emerged fry also might be vulnerable to heavy sediment loads. Larger fish are more mobile and would be expected to avoid construction activity.

Salmon and trout would be the most significantly impacted fish. Most of the sediment would be transported downstream during the first high-flow period. Consequently, it is likely that at most only 1 year-class or single age group of salmon could be heavily impacted by severe sedimentation in the construction phase. Impacts would occur primarily at the crossings and a short distance downstream. Any major fish mortalities could reduce subsequent spawnings of that species for several cycles.

Mortalities probably would be within the range of natural fluctuation, and impacts to ocean fisheries probably would not be noticed. However, impacts to stream fisheries may be noticed. Sedimentation would have less effect on fish in streams that characteristically carry heavy sediment loads such as the Skagit and Nooksack Rivers.

Fuel oil could spill and enter streams during construction. Such spills could result in fish kills, or tainting of fish flesh, depending on fish present at the time. Details of oil spill impacts are discussed in the operation phase section.

Tables 8.4.3-35 and 8.4.3-36 summarize project impacts in general and provide specific details for major streams crossed.

Operation Phase

Sedimentation could continue to impact streams in the operation phase, depending on the rate of revegetation at crossing sites. Steep slopes, unstable soil, and high runoff areas could present serious sedimentation problems, as revegetation would be impaired. Sedimentation impacts would be the same as discussed for in the construction phase but of lesser magnitude.

An oil spill would be the major threat to aquatic life. A spill would release oil downstream of the crossing which, in most cases, is relatively close to the mouth of the rivers (exceptions are the Dungeness, Noosack, and Sumas Rivers). Large oil spills could travel many miles downstream depending on location of rupture, volumes spilled, oil viscosity, river flow rates, and sorbtive capability of downstream riverbanks. In most, if not all, cases large spills could reach marine areas at the river mouth.

Major spills could reduce fish populations and influence stream systems for a year or more, until harmful quantities of oil residues were removed from gravels, streamside areas, and the water itself. Unlike sedimentation, a large spill could entail multiyear impacts.

Impacts on salmon would vary with their life history. Elimination of a year-class of migratory salmon that spawn every 2, 3, or 4 years could reduce future spawning runs for several years thereafter. Impacts on odd-year pink salmon runs could be noticeable for many years. This would apply to the Lyre, Elwha, Dungeness, Stillaguamish, Skagit, and Nooksack Rivers and several smaller streams. Sockeye salmon are supported only in two rivers crossed by the pipeline, the Skagit and Nooksack. Impacts on these species could result in critical population reductions in these rivers.

Population reductions of salmon probably would not be noticed in ocean fisheries due to the multitude of salmon streams in western Washington. A particular stream, however, could have noticeable reductions, depending on the number of fish killed or the timing of a spill.

Little is known of the effects of crude oil on freshwater habitats. However, it is apparent that large oil spills could cause severe ecological damage. The severity of the impact would depend upon (1) the quantity and type of oil spilled, (2) stream volume at the time of the spill, (3) stream flow rate and bed type (silt, gravel, sand), (4) species present, (5) life stages of the species present, and (6) effectiveness of spill containment and cleanup.

Spill impacts could range from complete elimination of all fish and fish food organisms for several miles downstream in the case of large spills, to no detectable impacts if spill volumes and concentrations were low.

Oil spills during low stream flow would have greater toxicity due to higher oil concentrations and a limited flushing rate. A spill occurring during a higher flow period would have less toxic effects; however, it would be more difficult to clean up and the likelihood of oil being carried downstream to the marine environment would be greater. Higher flows would flush the stream more rapidly and serve to dilute the spill, but oil would be distributed over a larger downstream area.

Turbulent mixing action of flowing water would emulsify spilled crude oil, causing it to contact virtually all downstream microhabitats. Oil would mix with spawning gravels, and coat rocks, debris, and sandbars along the waterline.

Oil could cause direct mortalities to fish by interferring with respiration, destroying eggs or fry in the gravel, and by direct toxicity to the fish. Indirect impacts could include (1) interruption of oxygenation of gravel containing eggs and fry, (2) mortalities to aquatic insects, (3) tainting of fish flesh, (4) deoxygenation of waters from oil decomposition, (5) interference with sense of smell and other environmental clues necessary in migration and other activity, and (6) narcotization of fish (causing them to be swept downstream with the oil and subjecting them to beaching, predation, and lethal exposures to the oil itself).

Salmon would be most affected if a spill occurred during spawning (resulting in the loss of eggs and unspawned adults), or when fry are emerging from the eggs. Rice, et al. (1975) showed that emergent pink salmon fry were more sensitive to Prudhoe Bay crude oil than were eggs.

Speculation exists that oil spills in the ocean, at the mouths of anadromous fish streams, might block the upstream movement of adults or the seaward exit of salmonid smolts. Even if such a blockage did not occur, the presence of oil would be expected to add stress at a time when these migratory fish are already under some stress in the transition to or from the ocean. In either case, additional mortalities could occur, particularly for the downstream migrating smolts adjusting to an ocean existence. Delays of upstream adult migrations for extended periods (on the order of weeks) can be expected to reduce spawning success.

An oil spill entering fresh water also could affect populations of amphibians. See the discussion on Oil Spill Risk Analysis earlier in this section.

Abandonment Phase

The abandonment phase could cause sediment-related impacts, similar to those of construction. However, fewer impacts and minor fishery losses would be expected in most cases because the pipe would be left in place at major stream crossings. Impacts associated with fuel oil spills also could occur.

TABLE 8.4.3-35
SUMMARY OF IMPORTANT IMPACTS TO FISHERY RESOURCES

Fishery Resource	Impact	Construction			Operation			Abandonment		
		Intensity	Duration	Magnitude	Intensity	Duration	Magnitude	Intensity	Duration	Magnitude
Salmon and trout, both searun and resident. See table 8.4.3-36 for specific streams supporting these fishes.	SEDIMENT	Moderate at most stream crossings. Siltation from in-stream excavation.	1 year or less. Generally until high flows flush sediment from gravel.	Several hundred feet down-stream from crossing.	Moderate. Low at most stream crossings. Sediment influxes would occur during runoff from stream-bank erosion.	For the project life but decreasing at most crossings throughout project life.	Several hundred feet downstream from crossing.	Low at most stream crossings.	1 year or less. Generally until high flows flush sediment from gravel.	Several hundred feet down-stream from cross-ing.

Fishery Resource	Impact	Fuel Oil Spill			Pipeline Rupture			Fuel Oil Spill		
		Intensity	Duration	Magnitude	Intensity	Duration	Magnitude	Intensity	Duration	Magnitude
Salmon and trout, both searun and resident.	OIL SPILL	Low in most cases because of small volumes.	Duration of the spill in streams. Several months residual impact in some cases.	Several miles down-stream from spill.	High in most streams. High in most salmon streams.	Impact would be for the duration of the spill. Several months to years residual impact in some cases.	Several miles downstream from spill. Large spill would affect stream all the way to the mouth.	Low in most cases because of small volumes.	Duration of the spill in streams. Several months residual impact in some cases.	Several miles down-stream from spill.

TABLE 8.4.3-36
SUMMARY OF IMPACTS ON MAJOR FISHERY RESOURCES IN SELECTED STREAMS[1]

Stream	Pipeline Miles	Significant Spawning Habitat[2]	Construction	Operation				Abandonment
			Sediment Impacts		Oil Spill Impacts			Sediment Impacts
			Streambed Sediment[3]	Streambank Erosion[3]	Hatchery Operations[4]	Indian Fisheries[5]	Juvenile Fish Populations[6]	Streambank Erosion[7]
Lyre River	1	yes	low	low	---	---	low	low
Elwha River	12.5	yes	low	low	Moderate. Loss of exposed juveniles released upstream	Disrupted and reduced catches	moderate	low
Dungeness River	32.5	yes	low	low	Moderate. Loss of exposed juveniles released up and downstream of crossing	Disrupted and reduced catches	moderate	low
Skagit River	101	no	low	low	Moderate. Loss of exposed juveniles released upstream	Disrupted and reduced catches	high	none
Samish River	105	yes	low	low	Moderate. Loss of exposed juveniles released upstream	Disrupted and reduced catches	moderate	low
Nooksack River	138.5	yes	moderate	low	Moderate. Loss of exposed juveniles released upstream	Disrupted and reduced catches	moderate	low

[1] Refer to Aquatic Resources sections in chapter 8.4.2 for more detailed information concerning spawning habitat, hatcheries, and Indian fisheries.

[2] Significant spawning habitat for salmon and trout in crossing area.

[3] Estimated impact on salmon and trout populations produced in area immediately downstream from crossing.
High = Reduction to below normal range of fluxuations.
Moderate = Reduction to near the low range of fluxuations.
Low = Reduction would be within normal range of fluxuations.

[4] Estimated impact on fish populations associated with appropriate hatchery. Assumes large number of juvenile fish present and exposed to oil.

[5] Estimated impact on Indian river fisheries. Disruption of fishing activities would occur during and immediately after an oil spill. Reduced catches could occur on subsequent spawning runs and during the current run if adult mortalities occur.

[6] Estimated loss of naturally produced salmon and trout (nonhatchery fish). Based on length of stream and number of fish likely to be exposed to oil under worst-case conditions.

[7] Disturbance to streambanks and resulting erosion is expected to be minimal to low in all cases.

MARINE RESOURCES

This section addresses salt water resources.

Physical Components

Construction Phase

Placement and burial of the pipeline in Admiralty Inlet and Saratoga Passage would degrade the water quality during the construction period. If bedrock is encountered, blasting might be required for pipeline burial. Burying the pipeline in the ocean floor would increase the concentration of suspended sediments.

Suspended solids would be transported from the trench by waves and currents. Large particles would settle rapidly while smaller particles would be carried further. Some of the heavier sediments would permanently resettle to the bottom and not be eroded by currents.

Pipeline burial at major river crossings also could introduce suspended sediments into the estuaries during high flow periods.

Operation Phase

Under normal operation of the pipeline no adverse impacts are expected. The most significant impact would result from an oil spill or a pipeline leak in the shoreline area or offshore.

Reported frequency of a 115-barrel submarine pipeline spill between Nodule Point and Bush Point in Admiralty Inlet is once every 238 years. The maximum credible spill of 2,000 barrels could occur once every 84 years (TMC 1979). The frequency of a 115-barrel submarine pipeline spill in Saratoga Passage is one spill every 400 years; a maximum credible spill of 11.000 barrels could occur once every 212 years. The calculated spill risk for the pipeline between Low Point and Sumas is one spill of 622 barrels every 3.2 years (TMC 1979).

No trajectories are available for oil spills from either trans sound pipeline. However, tidal/current data indicate a pipeline rupture and oil spill in Admiralty inlet would impact Hood Canal, Puget Sound to Seattle and southward, and the central basin of the Strait of Juan de Fuca (west of Whidbey Island). An underwater pipeline spill in Saratoga Passage could impact Skagit Bay, Holmes Harbor, Port Susan, and Possession Sound, and possibly Padella Bay. The extent of impacts would depend on the volume spilled, and range from minor for a small spill to major for a large or catastrophic one.

In the event of an underwater pipeline rupture in Admiralty Inlet, water quality would be degraded in the eastern Strait of Juan de Fuca, Hood Canal, and Southern Puget Sound. Hood Canal water quality could remain degraded for a long time, as it flushes very slowly. A pipeline spill in Saratoga Passage also could degrade water quality in the Whidbey basin for an extended period of time since it too has a long flushing time.

Abandonment Phase

Because the pipe would be sealed and left in place there would be a negligible impact on physical marine resources.

BIOLOGICAL COMPONENTS

Impacts upon marine biological components are covered earlier. This section summarizes potential impacts on several areas along the pipeline corridor; Sequim Bay, Discovery Bay, Protection Island/Dallas Bank, Admiralty Inlet, Hood Canal/west shore of Whidbey Island (West Shore), Smith and Minor Islands, Skagit Bay, and Saratoga Passage.

Sequim Bay

The Washington Department of Ecology considers this to be a very important area and lists it as critical habitat for Pacific herring, capelin, and mallard and pintail ducks. Major hardshell and geoduck clam beds are present and Pacific oysters are cultured here. The slow water exchange rate in the bay means that any contaminants entering the bay will remain for extended periods.

A 1,000-barrel oil spill could produce major impacts upon the marshes and eelgrass beds and organisms dependent upon those habitats. Moderate to major impacts on clams would occur. The continued recontamination of clams from oiled sediment would prolong these effects. Pacific herring would suffer moderate to major impacts, depending on whether the spill interfered with spawning. Anadromous fish in the bay could be permanently displaced. It is more likely, however, that the impacts would be moderate.

Mallard ducks feed on eelgrass. Since even low levels of oil can lead to declines in eelgrass (due to increased susceptibility to parasitic attack) the ducks could be displaced. Many other waterfowl species feed on organisms dependent on eelgrass--these birds too could be impacted. Direct oiling of several bird species (such as brandts and rhinoceros auklets), is anticipated to cause major impacts.

Discovery Bay

Because of similarities between Discovery and Sequim Bays impacts probably would be very similar. Discovery Bay has a much more rapid flushing rate, and would naturally removed in a shorter time. Impacts upon Pacific herring are suspected to be major. Bottom fish would experience minor impacts and anadramous fish minor to moderate impacts. Chances of anadramous fish displacement from Discovery Bay are slight. Hardshell and geoduck clams will probably experience moderate impacts. Pacific oysters are not cultured here.

Western grebes and rhinoceros auklets inhabit this area. Their behavior makes them highly susceptible to oiling, and both species would suffer major impacts. The rhinoceros auklet colony is the largest south of Alaska--major population reductions could have far-reaching effects.

Protection Island/Dallas Bank

Oil spills would have the greatest impact on birds. Five species have critical habitat here. Major impacts would be expected for rhinoceros auklet, glaucous winged gull, pigeon guillemat, and pelagic cormorant. The black oyster catcher's behavior causes it to be rarely oiled (Gardner 1978), hence anticipated impacts are minor. However, any bird, once oiled is very unlikely to survive. The eastern portion of the island is critical habitat for harbor seals. Impacts probably would be moderate. Large kelp beds over parts of Dallas Bank are expected to suffer minor impacts because kelp's jelly-like coating provides resistance to oil. The hardshell clam beds probably will sustain moderate impacts. Impacts upon all resources will be partially mitigated because the water flowing around the island and trench will help remove and dilute the oil.

Admiralty Inlet/Hood Canal

This discussion will cover Admiralty Inlet, the upper reaches of Hood Canal (to Seabeck), and the juncture of Admiralty Inlet, Puget Sound, and Possession Sound. The proposed pipeline crossing from Indian Island to Marrowstone Island to Whidbey Island would expose organisms to impacts from construction and operation.

Construction

The sediments along the pipeline route (from west to east) are sand, gravel, gravely sand, sandy mud, sandy gravel, and gravel. Chlorinated hydrocarbons, trace metals, agricultural phosphates, and other potentially harmful substances would be expected in clays and muds. Hence, only operations in the sandy mud section are likely to cause these materials to be resuspended. Impacts (if the substances are present) should be minor, due to the short stretch of sandy mud involved.

Pipeline construction in all areas will produce sediment plumes which will reduce light available for photosynthesis, cause chemical changes, and reduce oxygen levels. Filter-feeding animals can become clogged with excessive exposure to fine sediments. Sediment plumes also will be created during river crossings and the increased sediment would be transported into the marine environment. Because of the coarse nature of the sediment, the above impacts should be minor.

A third category of impact is actual crushing or burying. Goodwin and Shaul (1978) have identified major hard shell clam beds at the west and east end of the pipeline crossing. The beds have been estimated to contain over 11,8 million pounds of butter, little neck, and horse clams. Constructing a pipeline through these beds could have major impacts.

Operations

This region is biologically rich and diverse, and many species and habitats here are vulnerable to oiling. The two hardshell clam beds just discussed would suffer major impacts if oiled. Their proximity to the proposed pipeline route makes this event more likely. Clams which survived the initial oiling would be recontaminated for long periods (months to years) by oil in the sediment. They would be unfit for human consumption and contaminate birds or fish feeding upon them. Other important clam beds in this region, such as the very large geoduck bed near Port Gamble, also would be expected to suffer major impacts. Pacific oysters are extrememly important here, particularly in Dabob Bay. A spill on a river draining into Dabob Bay or Admiralty Inlet could have a major impact upon the oysters. The marshes and eelgrass beds, and associated organisms, could sustain major impacts. It should be noted that these habitats are essential to many species at various times. Salmon fry, for example, spend much time in eelgrass beds and could suffer major impacts if the beds were oiled. Kelp beds and most bottom fish probably would experience minor impacts. Pacific herring and surfsmelt are the two most vulnerable fishes and have critical habitats in the area. Their intertidal and shallow subtidal spawning habits subject them to potentially major impacts. An oil spill could reduce the populations for several years.

Oil destroys the insulating properties of the river otter's fur, exposing them to the cold. Impacts could be major. Harbor seal impacts probably would be moderate. Eleven species of birds are listed as having important or critical habitat here (Dept. of Ecology 1977). Gardner (1978) lists 5 of the 11 as often oiled or highly susceptible. Once oiled, birds very rarely survive. Water in the Hood Canal segment becomes highly stable and stratified in the summer. This could worsen the impacts described for organisms and habitats along Hood Canal.

Whidbey Island (West Shore)

No critical habitats are listed here and the area is less sensitive to potential project impacts than the other areas discussed. Kelp beds are found along much of this coast. Impacts to the beds from construction could be moderate if the pipeline passed through a kelp bed. Recovery, however, should be complete within a year. Anticipated impacts to kelp beds from construction and operations are minor. Eelgrass beds could sustain moderate to major impacts from an oil spill. A major geoduck clam bed is located north of Point Partridge. If the pipeline were placed through the bed major impacts would result. If the pipe were placed outside the bed impacts would probably be minor because of coarse uncontaminated sediment. An oil spill would have a major impact on the beds.

Smith and Minor Islands

Kelp beds ring much of the coast around these islands, and will help keep the oil off, while sustaining only minor impacts. The mixed-fine intertidal substrates and associated organisms would be most vulnerable to a spill. The natural water movement around these islands would help remove spilled oil. Minor Island is a critical habitat for the glaucous winged gull, whose habits make it likely to suffer major impacts in the event of a spill. The same is true of rhinocerous auklet and pigeon guillemot on Smith Island.

Skagit Bay

This bay is vulnerable to major impacts from construction and operation due to slow water exchange rates. During construction of the pipeline large areas of fine sediment will be crossed, resulting in large sediment plumes. It is expected that these sediments have high levels of phosphates, pesticides and other substances associated with the agricultural lands that drain into Saratoga Passage. When resuspended, the materials could have moderate impacts upon the major soft shell clam beds, hard shell clam beds, Pacific herring, and surf smelt. The latter two would be most affected in spawning season. Construction impacts to birds probably would be minor.

The hard and soft shell calms, crabs, Pacific herring, and smelt in this area could sustain major impacts from a 1,000-barrel spill. Impacts would be greatest if the spill coincided with spawning.

Critical habitats for steelhead and American shad are located in the bay. Oil could destroy or displace these and other anadramous fish, resulting in moderate impacts. The extensive mud flats, salt marsh, and eelgrass beds, and their associated organisms are all very vulnerable to oiling. For example, oiled mud flats in the east bay could have moderate impacts on the long billed dowitcher and western sandpiper, even though these species normally do not become oiled due to their habits and habitat preference (Gardner 1978). These mud flats are rated as important habitat for the dowitcher and sandpiper. Damage to eelgrass beds could produce major impacts upon mallards and American wigeon. Both birds have critical habitat here and depend upon eelgrass for food. The whistling swan and snow goose also have critical habitat here, but would be less susceptible to impacts. Otters in the Skagit River would not be affected unless they enter the river mouth during a spill.

Saratoga Passage

Water changes slowly in this area, causing contaminants to be retained longer, and increasing the severity of impacts. Shell fish are an important and vulnerable resource. A major geoduck clam bed, plus intertidal and hard shell clam beds occur here, as well as Pacific oyster culture and spawning areas in Holmes Harbor and Penn Cove. Both crab and shrimp support commercial fisheries. The above shellfish could sustain moderate to major impacts during construction and operation. Clams probably would experience the greatest impacts. Surf smelt (critical habitat) and Pacific herring probably would experience moderate to major impacts from construction and major impacts from an oil spill. Impacts to other fish species probably would be minor.

River otters, found in Holmes Harbor, could suffer major impacts.

Young white pelicans in nesting colony

U.S. Fish and Wildlife Service

TERRESTRIAL VEGETATION

Construction Phase

Vegetation will be removed for construction purposes along 148 miles of pipeline route. Since some of the 90-foot corridor will overlap with other rights-of-way, and it is not known how much widening could occur, no attempt will be made to quantify how much of the corridor will be in forest and how much will be in existing corridors (mostly shrubby vegetation). A total of 1,585 acres of land would be cleared (approximately 5.5 miles of pipeline will be under marine waters, therefore resulting in no land disturbance). As described in section 8.4.2, nearly 40 percent of the pipeline corridor crosses agricultural lands, and 53 percent crosses forest lands. Ocean and urban areas make up most of the remainder.

The proposed 2-mile-wide study corridor would allow the pipeline to be routed around areas of special concern when consulting with the agency or individuals involved.

Several freshwater and saltwater marshes would be impacted by pipeline construction. Accidental drainage of a marsh may occur if the impermeable bottom is trenched for pipeline installation. The Skagit River delta supports an immense salt marsh which lies several hundred feet from the proposed route, as does another marsh near Milltown in Skagit County. Accidental spills of toxic substances in this area would be carried into the marsh system by surface or underground water.

One plant species, Calamagrostis crassiglumis, which is proposed as a threatened species on a 1978 federal list by Ayensu and DeFilips, is known to occur near the proposed pipeline corridor in the vicinity of Lake Whatcom (WNHP 1979). No surveys have been conducted within the corridor to determine its presence.

Operation Phase

Approximately 53 percent of the corridor runs through forest land and would require vegetation control. The entire land portion of the pipeline right-of-way would require maintenance and be susceptible to unauthorized vehicle use damage.

Woody vegetation and noxious weeds would not be allowed to grow on the right-of-way, in order that maintenance and monitoring work may be carried out.

Vegetation control may involve mowing, cutting, and/or herbicide use. Mowed rights-of-way would give rise to grasslands and early successional shrublands. Where woody vegetation is controlled by herbicides, common species remaining on rights-of-way are found to be desirable for many wildlife species. In western Washington such species would include salmonberry, elderberry, willow, and orchard grass (NTPC 1978). Undesirable effects of herbicides include drift onto adjacent areas, increased erosion and higher soil temperatures caused by reduced ground cover, loss of nitrogen-fixing plants (red alder and snowbush), herbicide contamination of water and soil, and subsequent entry of the pollutants into the food chain.

The presence of the right-of-way and associated access roads would encourage unauthorized use by off-road vehicles and motorcycles. Revegetation can be retarded by too much vehicular traffic, which results in excessive soil compaction and plant damage, or causes rut formation which leads to erosion.

The trees bordering the cleared corridor would be subject to wind damage and related impacts, discussed in the Terrestrial Vegetation discussion earlier in this section.

The possibility of an oil spill occurring along the pipeline during the life of the project is discussed earlier in this section. Some of the most sensitive areas are marshes and farmland, where oil would do the most damage to non-woody vegetation. The Skagit River delta supports an immense salt marsh and wide variety of bird life. It lies several hundred feet from the proposed corridor, and could be severely impacted by an oil spill in this area.

An oil spill occurring under water could affect a wider area due to currents spreading the oil. However, acreage of affected vegetation probably would not be as great as a spill on land, and would occur primarily in river bank, marsh, and coastal plant communities. Cleaning up of this type of spill would likely be faster and easier also.

Calamagrostis crassiglumis, proposed for threatened status on several federal lists, may be adversely affected by oil spills near Lake Whatcom or herbicids drifting from the corridor during the life of the project. No oil spill trajectory has been forecast for a potential spill near pipeline mile 125, which lies within one-half mile of the northwest shore of Lake Whatcom. Therefore, probable impacts to this species cannot be accurately predicted.

Abandonment Phase

The pipeline would be removed, with impacts similar to those of construction, except where it crosses roads or waterways. Here it would be filled with an inert material and capped.

Removing the pipeline would damage the shrubby vegetation which had been allowed to grow in the corridor, aggravating soil erosion. Areas where soil has been compacted by maintenance or unauthorized vehicle use would be difficult to revegetate--seeds will not establish easily on these areas and moisture penetration will be restricted. In addition, unauthorized vehicle use would likely continue in some areas after abandonment. A permanent road corridor probably would remain. Such areas probably would not return to a natural state in the forseeable future.

No threatened or endangered species are anticipated to be impacted adversely during the abandonment stage.

TERRESTRIAL WILDLIFE

Construction Phase

Vegetation clearing and pipeline installation would cause a loss of wildlife habitat along previously undisturbed portions of the route.

Woodland would be removed on the Olympic Peninsula, Whidbey and Camano Islands, and between Samish River and Laurel. Impacted species would include band-tailed pigeon, great horned owl, northern flying squirrel, black-tailed deer, and raccoon. Predominantly agricultural lands will be removed between Stanwood and the Samish River and between Laurel and Sumas. Impacted species would include birds of prey (red-tailed hawk, marsh hawk), game birds and mammals, furbearers and small mammals.

A small amount of wetland would be removed between Laurel and Sumas, impacting waterfowl, muskrats, beaver, and raccoons. Loss of riparian habitat at river and stream crossings, numerous throughout the route, could affect furbearers such as beaver, river otter, and raccoon. Removal of breeding habitat and streambank vegetation used for escape cover could have long-term adverse impacts on waterfowl and riparian wildlife.

Clearing the second-growth mixed forests, typical of the Olympic foothills and Whidbey and Camano Islands, will increase the quantity of "edge" habitat (shrubs and grasses) in the region. Deer, ruffed grouse, snowshoe hare, and cottontails are expected to benefit. Edge habitat supports a greater diversity of species than homogeneous plant communities and is considered desirable for wildlife management.

Wildlife would be most severely impacted if construction occurred during breeding or migration periods. Birds may abandon nests if disturbed early in the breeding season; even short-term flushing of adults may result in a loss of young due to exposure. Those corridor sections which pass near prime bird habitat, such as the Skagit flats, would be of major concern.

Operation Phase

Operation impacts on terrestrial wildlife include habitat alteration by maintenance activities, disturbance from increased accessibility, and potential oil spills.

Woody plant control programs will maintain the corridor in an early stage of successional growth (shrub and grass communities). The newly created "edge" habitat would be maintained for the duration of the project.

Corridor use by maintenance and unauthorized vehicles (motorcycles, snowmobiles) may disturb wildlife and promote avoidance. Easier access for recreationists and hunters to isolated areas may cause increased disturbance and hunting pressure.

Oil spills can affect wildlife either directly by toxic effects or indirectly by destroying or altering habitat. Small mammals, ground birds, reptiles, and amphibians, unable to escape an oil spill, may die by suffocation or from toxic effects associated with ingestion and absorption through the skin. Larger, more mobile wildlife (deer, elk, bear) can avoid contact with oil, but may suffer a minor habitat loss, or feed on oil-contaminated food sources.

The most significant operational impact would be from oil leaking into a wetland and dispersing. Birds that contact oil in wetlands may be impacted by lack of buoyancy, exposure (oil-coated feathers lose insulation), and toxicity of ingested oil which affects kidney function. An oil spill into the Skagit tidal flats and marshes would be critical as this area provides prime habitat for bald eagles, and for breeding and migrating waterfowl, including 20,000-35,000 snowgeese.

Mammals which forage along riverbanks, such as river otters, muskrats, mink, beavers, and raccoons would be susceptible to oil which may contaminate riparian habitat. If furbearers become covered with oil, their dense fur becomes matted and loses insulative qualities. Exposure and death may result. Mammals attempting to lick the oil off their fur may sicken. Terrestrial mammals and birds may ingest oil as they attempt to drink or feed.

A spill during the spring breeding season could have a long-term effect on terrestrial animals. Young ground or marsh nesting birds could become coated and unable to escape the spill. Eggs could be destroyed. Young mammals could ingest oil from the mother and suffer toxic effects.

Rare, Threatened, and Endangered Species

Species which are considered rare, threatened, or endangered by the State of Washington and by the federal government include peregrine falcon and northern bald eagle.

Wintering habitat and feeding areas used by the peregrine falcon may be disturbed by construction and abandonment activities near Burlington.

Of prime concern is the northern bald eagles (threatened status) which may be impacted by construction disturbance. The closest nest sites are 1) the western shore of Killsut Harbor, near Kinney Point on Marrowstone Island; and 2) near Triangle Cove on Camano Island. These nests are within one-half mile of the proposed corridor (Washington Department of Ecology 1978a, 1979). A resident population also occurs south of Woodmans along Point Discovery. Noise, removal of scavenging and feeding areas and habitat alteration could reduce the breeding population of bald eagles.

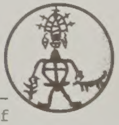
Wintering habitat also occurs in these areas and along Holmes harbor of Whidbey Island and Ustalady Harbor at Camano Island. Removal of roosting trees and feeding areas, and disturbance could reduce winter habitat.

The exact distance of the sites from the right-of-way cannot be determined at this time, but if they are within a critical distance (approximately 1,000 feet) eagles may abandon their nests. Northern bald eagles in the region would probably avoid the corridor areas during construction.

Oil contamination of birds and fish in northern Puget Sound could indirectly impact bald eagles scavenging the intertidal beaches. Ingested oil from contaminated food or water could result in impaired kidney functions, susceptibility to stress and disease, and abnormal feeding and reproductive behavior.

Abandonment Phase

Wildlife associated with early successional habitats or edge species would continue to utilize the right-of-way and gradually invade the vacated onshore facilities area. The species composition would change as the corridor underwent various successional changes. As trees on the corridor matured, deep-wood or sensitive species probably would return. Species dependent upon the enhanced edge effect, such as deer and grouse, may decline in numbers.



CULTURAL RESOURCES

Archaeological, architectural, historical, and paleontological resources are extremely fragile. Impacts could include displacement, damage, destruction, or burial of cultural materials by project actions. Generally, damage results when the resources are disturbed, and considerable value is lost. The potential exists for damaging cultural resources wherever construction activity took place on previously undisturbed portions of the pipeline right-of-way; at access roads and utility corridors; at borrow, disposal, and pipe storage areas; and at new pump station sites. There also could be inadvertent damage to cultural resource sites by vehicles and machinery operated outside the boundaries of the construction work area, oil damage, or emergency clean up activities.

There is potential for discovery (and destruction or preservation) of unrecorded cultural resources where the pipeline route does not follow previously disturbed rights-of-way.

Archaeological and Historical Resources

Existing resource inventory data and project information are not adequate to determine potential impacts. Site data are inadequate in two ways: 1) field inventories have not been done, and existing sites may be unidentified, and 2) the condition and significance of most known sites has not been evaluated.

Construction Phase

Potential effects on archaeological and historical resources would occur primarily during construction.

Right-of-way clearing would have moderate potential for direct impacts on cultural sites in general, but have high potential for impacts to surface and near-surface archaeological sites. The intensity of impacts would depend in part upon the equipment and techniques used for clearing.

Grading, excavation, and trenching have high potential for direct impact on cultural resource sites, while trench backfilling and right-of-way restoration would have relatively low potential because any resources in the work areas probably would have been disturbed earlier by construction activities.

Operation Phase

The operation of the pipeline system probably would have no direct impacts on archaeological and historical resources. Impacts might occur from oil spills and cleanup measures.

Abandonment Phase

The expected effects of project abandonment on cultural resources would depend upon how much excavation and pipe removal was to be done and on the adequacy of data recovery operations carried out to mitigate adverse effects of original construction. If mitigation projects were thorough and if excavation was confined to the original construction areas, the potential for additional impacts would be low. The potential for impacts would be high in areas such as borrow pits, access roads, and pipe loading areas previously unsurveyed for archaeological resources.

Paleontological Resources

Construction Phase

Paleontological materials could be directly affected where the ground was not previously disturbed. Deposits of fossils at or near the surface would be affected by grading and traffic. Subsurface fossils would be affected by pipeline trenching, excavations for foundations at pump station sites, and at borrow pits.

Operation Phase

Operation of the pipeline is not expected to have any direct impacts on paleontological resources. Indirect impacts potentially would occur from collectors being attracted to newly exposed fossil deposits or to known deposits resulting from improved access.

Abandonment Phase

The impacts of project abandonment would depend on the extent of pipe removal and on the adequacy of data recovery operations carried out to mitigate adverse effects of original construction. Overall, the impacts of abandonment are expected to be less than those of project construction.

VISUAL RESOURCES

Construction Phase

Clearing vegetation from the pipeline right-of-way would result in an immediate visual impact. A swath cut through dense forest on steep slopes would contrast sharply with the previously undisturbed environment. Only about 34 miles of the pipeline route would pass through undisturbed areas, as much of the proposed pipeline would parallel existing corridors or rights-of-way. The construction impacts associated with installation of a new pipeline along existing corridors or rights-of-way would be significant, but would not persist.

High visual impacts of pipeline construction would occur at marine crossings, as the ascent and descent of coastal bluffs would require extensive cuts. The construction equipment both onshore and in the water, would cause high visual impacts to observers on vesels in Admiralty Inlet and Saratoga Passage. Major marine crossings include Oak Bay, Admiralty Inlet, and Saratoga Passage. Lay barges, if used for marine crossings, would have a temporary visual impact.

Pump Stations

A total of three pump stations would be constructed. One would be located at the Low Point onshore storage site, as discussed earlier. The other two pump stations would be located at Fairmont (pipeline mile 8) in Clallam County and at Burlington (pipeline mile 102.5) in Skagit County.

The Burlington pump station would be located near the station for TMC's existing pipeline. Because the final location of the Fairmont pump station has not been determined, the following discussion will address the sttion's potential visual effects in a general sense only. The impact of the Burlington pump station would be somewhat less since it would be located near an existing pump station.

Pump station construction would require minor land-form modification. A 1.15-acre rectangular tract of land would be cleared and leveled, the contrast causing an adverse visual impact. Minor grading for access roads would create similar effects.

Visual impacts of the pump station will be largely determined by the site's exposure to public view.

Operation Phase

The primary visual impact of the pipeline during operation would be the cleared right-of-way corridor. The corridor would most be apparent in forested areas and would persist as a significant visual impact to viewers.

In pasture or cropland, the right-of-way would be revegetated within approximately 1 year and be virtually imperceptible in the landscape. The proposed route follows existing corridors and rights-of-way for approximately 77 percent of its total length. The impact of a new pipeline within existing corridors or rights-of-way would be insignificant after vegetation returns.

The appearance of a pump station would contrast significantly with surrounding forestlands or open fields (farmlands, meadows). The visual impact of a pump station would depend on the number of viewers and relative contrast with the surroundings (industrial building vs. agricultural land).

An oil spill could cause adverse visual impacts in widespread areas, especially shorelines.

Oil would adversely impact water color and quality. Dead fish and vegetation lining the banks and shorelines would be another visual impact.

Cleanup operations would remove contaminated soil, cobble, or vegetation, leaving the shoreline or streambanks barren. Modifications in the natural form, line, color, and texture would persist for at least 2 years, diminishing over the life of the project.

In sensitive viewing areas, these visual impacts could be extremely disturbing to the observer.

Abandonment Phase

Impacts from removing the pipeline would be similar to those of construction. The cleared pipeline right-of-way would persist for a considerable time, contrasting with forest areas. The right-of-way swath eventually would disappear, eliminating any adverse visual effects associated with the facility.

Pump station sites, when abandoned, should cause high visual impacts only during removal. Impacts would be similar to those described for construction.

LAND USE

The primary impact on land use from pipeline construction would be conflict with existing uses. Certain land uses, including most cultivated crops and forage production, can coexist with the pipeline. Other uses such as timber production, or intensive uses involving improvements, cannot.

Certain features of the pipeline system would preclude other uses, including pump stations, valves, electric substations, and communication sites. Additional land areas would be needed temporarily for storage yards, borrow pits, and spoil disposal. Construction of the pipeline would require an approximately 90-foot right-of-way.

Construction Phase

Urban

About 2 percent (36 acres) of the pipeline would be constructed near numerous urban fringe areas, indicated on table 8.4.2-46. Construction would cause nuisance impacts of noise, dust, travel delays, and visual disharmony up to 2 weeks in any one locale (assuming a one-half mile per day construction rate). Individually, these nuisance impacts would not be considered significant; however, in combination they might be so regarded in certain locations along the route.

Agriculture

Construction in agricultural and grassland areas, 38 percent of the total route (679 acres), generally would result in the loss of one year's crop. This loss would occur because most crops grown within the corridor require a full growing season. After construction, soil disturbance and compaction might decrease productivity for a few years depending upon soil conditions, trenching method, and restoration measures. Resulting losses in agricultural production would not be significant in terms of local (county) agricultural production.

About 270 acres of land with soils qualifying for prime farmland designations are found along the corridor. Since these lands are, or have potential to be, highly productive, pipeline construction might cause a significant impact.

Rangeland/Open Space

Rangeland and open space areas are minimal within the proposed pipeline corridor. No significant impacts should occur.

Forest/Woodland

Approximately 53 percent of the proposed route (945 acres) traverses forest or woodland. Construction activities would require clearing the trees within the right-of-way. However, this amount of woodland does not appear to represent a significant amount of the productive forest land within the counties affected. Construction impacts to forest land have been discussed earlier.

Native American Areas

Pipeline construction across Puget Sound might adversely affect areas used by Native Americans for fishing.

Natural and Scientific Areas

Pipeline construction would not cause any direct impacts to established natural or scientific areas. However, construction activity on any relatively undisturbed areas would destroy their value for future natural or scientific use. The likelihood of this occurring is unknown.

Wilderness

Pipeline construction would not cause any direct impact to established primitive or wilderness areas.

Land Use Plans and Zoning

The proposed project would be carried out in a manner consistent with land use plans, zoning ordinances, and the Washington State Coastal Zone Management Program. The latter program involves a number of state authorities for management, development, and protection of coastal resources including coordinated development of master land use plans and ordinances by coastal counties and cities under the Shoreline Management Act of 1971. TMC must file a statement with EFSEC (the lead agency for energy facilities) certifying that the proposed project is consistent with the program.

Operation Phase

Operation of the pipeline system would involve less land than would construction (1,794 vs. 1,345 acres).

Urban

Pipeline operation should result in no significant impact to urban lands due to the secondary uses that can be made of the right-of-way such as open space, greenbelt areas, recreation buffers, or utility corridors. The potential impact of pipeline failure resulting in an oil spill, fire, or explosion would be more severe within urban areas than elsewhere because of the more intensive surrounding uses and increased probability for loss of life. Since pipeline failures are often caused by outside parties, the likelihood of a failure may be higher in urban areas. Information is not available to assess the increased risk that might be associated with urban areas.

Agriculture

Normal operation of the pipeline system should not significantly impact agricultural land uses. The land area required for a pump station (approximately 1.15 acres) would not represent a significant amount of agricultural land within any one locale. An oil spill occurring on agricultural land might ruin a portion of one year's crop and decrease productivity for several years following the spill, if reclamation is effective. The extent of this impact would depend on the size and location of the oil spill, effectiveness of reclamation, season, soils, climate, and type of crop grown. Some damage to croplands would likely occur during the repair of a ruptured pipe.

Rangeland/Open Space

Rangeland and open space areas are minimal within the proposed pipeline corridor. No significant impacts occur during operation.

Forest/Woodland

Pipeline operation would remove forest lands from production for the 20-year life of the project. In terms of the total available and productive forest land within the affected areas, this impact does not appear to be significant. Forest lands might benefit from cleared rights-of-way serving as fire breaks or for access to forest fires, depending on the location. Trees adjacent to cleared rights-of-way would be more susceptible to wind throw (blowdown). Potential impacts on forest lands from oil spills are described in Terrestrial Vegetation earlier in this section.

Native American Areas

Normal operation and maintenance should not affect any Native American areas.

Natural and Scientific Areas

Operation (including possible oil spills) and maintenance should not cause significant impacts to most existing natural and scientific areas, although it might preclude the establishment of new areas.

Wilderness

Neither pipeline operation nor an oil spill would be likely to impact wilderness resources.

Land Use Plans and Zoning

In general, the pipeline would not seriously constrain land use plans and zoning since virtually all other land uses could occur reasonably close to the facilities, and since 77 percent of the pipeline would be parallel to existing corridors and rights-of-way.

Abandonment Phase

Except for major waterway and highway crossings, the pipeline, including pump stations, would be removed.

Urban

Abandonment would cause the same nuisances as those of construction, but the impacts could be more intense due to increased urban growth during the life of the project.

Agriculture

Removal of the pipeline could cause the loss of one year's crop on approximately the same acreage as that incurred for construction.

Rangeland/Open Space

Rangeland and open space areas are minimal within the proposed pipeline corridor. No significant impacts should occur.

Forest/Woodland

Removal of the pipeline from forest lands should have no significant impacts.

Native American Areas

Removal of the pipeline near Native American areas would cause essentially the same impacts as during construction.

Natural and Scientific Areas

Pipeline removal would not cause any direct impacts to established natural or scientific areas.

Wilderness

Removal of the pipeline near wilderness areas would cause essentially the same impacts as during construction.

TRANSPORTATION AND UTILITY NETWORKS

Inland Water Transportation

Construction Phase

The pipeline would cross water where significant levels of commercial vessel traffic exist.

Construction vessels could present a hazard, particularly during bad weather, to marine vessel traffic entering and leaving Admiralty Inlet (the main route to Seattle and Tacome) but minor inconvenience is anticipated because construction activity would leave ample maneuvering room and should be completed within 5 months. Crossing Saratoga Passage could be hazardous to sport boats.

Operation Phase

Normal operation of the pipeline should cause no adverse impacts to inland water transportation.

Oil spilled into inland waterways, Admiralty Inlet, or Saratoga Passage may have temporary adverse impacts on waterborne transport activities.

Abandonment Phase

Abandonment procedures should cause no significant impacts to inland water transportation.

Railroads

Construction Phase

Because the pipeline would be buried beneath the tracks, the impact to rail traffic should be limited to possible speed restrictions lasting for one week or less through the construction areas. Railroads generally have excess capacity; transporting construction materials probably would not cause any adverse impacts to rail service.

Operation Phase

Normal operation would cause no significant adverse impacts to railroads. An oil spill within a railroad right-of-way might cause temporary impacts from cleanup operations. In an extreme case rail traffic could be delayed temporarily.

Abandonment Phase

The pipeline would not be removed at crossings; no impacts would be expected.

Roads and Highways

Construction Phase

Some road damage would occur where construction equipment traffic would be concentrated, such as near storage yards and pump stations. Construction induced traffic might cause congestion on local roads of up to one month. This locally significant impact would be felt most severely near urban areas experiencing congestion from high seasonal traffic and lack of alternate routes.

Impacts also could occur where the pipeline would cross or be located adjacent to roads and highways. Roads and highways with high traffic volumes would be crossed by tunneling to minimize disruption. Trenched crossings of unimproved roads and those of low traffic volume would be accomplished by leaving one-half of the road open at a time. Crossings would be expected to cause traffic delays during the construction period (typically 1 to 3 days), which would be most severe on secondary roads with high seasonal traffic. An improperly rebuilt roadbed could place undue stress on the buried pipeline. Construction along roads or highways would have the most impact in mountainous areas without alternative travel routes, and in urban fringe areas where traffic densities are high. Some temporary access roads may be needed in some areas. The impacts of this cannot be determined at this time.

Operation Phase

Normal operation should not result in any significant impact to roads and highways. Minimal traffic would be generated by normal pipeline operation. In the event of a spill cleanup efforts might generate intensive traffic on local roads and highways near the site up to a week. An oil spill near a road or highway could require pipeline repair or cleanup which might disrupt traffic.

Abandonment Phase

Removal of the pipeline would cause impacts similar to those of construction, but of less magnitude. Salvage activity would probably be accomplished in less time, but would be likely to affect roads and highways with higher traffic volumes, especially near urban areas in which growth had occurred. It does not appear likely that significant impacts would occur.

Airports

Construction Phase

Construction equipment working near facilities such as Very High Omnidirectional Range And Tactical Air Navigation Aids, Radar Microwave Link Receivers, and Air Route Surveillance Radars could interfere with radiated signals and render the facilities unusable during construction. The FAA would then temporarily shut down any affected facilities, resulting in local impacts. Such impacts would be minor, as any affected air traffic would be provided with alternative navigation aids. Although pipeline construction could occur near several airports it is not likely any significant impacts would result.

Operation Phase

Under normal operation, inspection flights of the pipeline would be made every 2 weeks. These flights are not expected to add significantly to air traffic.

Abandonment Phase

No significant impacts are anticipated.

Electric Transmission Lines

Construction Phase

The increased electric loads required for construction would be negligible. Potential exists for physical damage to transmission lines and utility access roads along the estimated 26 miles of adjacent or shared right-of-way.

The pipeline would be located a sufficient distance from transmission towers to prevent any undermining of footings, ground mats, or pole guys. This distance would vary according to the size of the tower and its footing. Where the pipeline parallels wooden utility poles, existing pole guys could obstruct the pipeline, requiring adjustments. Construction in or around transmission lines increases the risk of contact with towers or conductors, which could result in outages. Excavation blasting could damage the powerlines. Excavation across utility maintenance roads could hamper access to the lines in emergency conditions, as access roads could be rendered impassable by heavy construction equipment. The significance of these potential impacts would largely depend on the location, extent, and type of physical damage incurred.

Right-of-way sharing might lessen the land-use impact described in chapter 3. The extent of this saving cannot be determined until detailed studies are completed.

Operation Phase

The electric power requirements would represent significant load increases for a number of local utilities which, like Clallam County Public Utilities District, have expressed concerns about providing firm power to TMC. Within the Pacific Northwest region, the possibility of power shortages depends upon such variables as weather conditions, conservation measures, and the completion dates of new nuclear power plants.

Electrical interactions between the pipeline and power transmission lines would be possible where the pipeline paralleled transmission line rights-of-way. These electrical effects are variable and depend on specific location, pipeline design, and electrical system conditions. Cathodic protection would be used during pipeline construction to prevent hazardous electrical shocks to personnel or pipeline integrity. A significant impact appears unlikely.

Abandonment Phase

The potential impacts to adjacent transmission lines would be similar to those of construction. Abandonment would decrease power consumption, causing some loss of revenue for local utilities. However, the additional power made available to other users would be a beneficial impact.

Communications

Construction Phase

Buried and overhead communication lines might be damaged and service disrupted by construction. This potential impact would most likely occur near urban areas where communication lines are concentrated. It is not likely that such accidents, if they were to occur, would significantly disrupt service. The likelihood of such occurrences is relatively small.

Operation Phase

A communication cable buried adjacent to the pipeline could be damaged by an oil spill and resultant pipeline repair activity. The significance of the impact would depend on the location and extent of the damage.

Abandonment Phase

Pipeline removal might cause physical damage to overhead or buried communication systems. Otherwise, abandonment is not likly to cause any significant impacts.

Unaffiliated Pipelines

Construction Phase

The possibility of physical damage to other major pipelines would occur at the 5 crossings and along 54 miles of right-of-way shared with TMC's existing pipeline. The impact of this unlikely, although possible, event would depend on the type of pipeline damaged and the location and extent of the damage.

Operation Phase

An adjacent pipeline might be damaged by interaction between cathodic protection systems or by an oil spill and resulting repair and cleanup activities. The impact of this possible event would depend upon the type of material transported in the pipeline, the location, and the extent of the damage incurred. It does not appear that pipeline operation would cause any significant impacts to other pipeline systems.

Abandonment Phase

Removal of the pipeline might damage adjoining pipelines, with impacts similar to those incurred during construction.

RECREATION

Construction Phase

Noise and congestion resulting from clearing, trenching, and related pipeline construction activities would disturb nearby recreationists and probably reduce desirability of these areas for the short term. Several parks are less than 1 mile from the proposed pipeline corridor including two campgrounds and a day-use area at Lyre River, Olympic National Park Visitors Center, Sequim Bay State Park, Anderson Lake State Park, Oak Harbor Beach Park, Mystery Bay State Park, and Skagit Wildlife Recreation Area. Traffic congestion and noise on U.S. Highway 101 and smaller roads also would inconvenience the majority of Olympic National Park users. U.S. 101 is the main highway providing access to the Olympic Peninsula. The proposed pipeline crossing of the Elwha and Skagit Rivers conflicts with the Washington Shorelines Management Act of 1971 which designates management for scenic and recreational values as priority. In addition, two crossings of the Skagit River above Mount Vernon may conflict with the proposed Wild and Scenic River Status.

Some parks may experience increased competition for use from construction crews and their families. Small county or city parks would be primarily affected, particularly in the Port Angeles vicinity.

The trans sound pipeline crossings would disrupt local marine recreation, including sailing, fishing, and shoreline activities during construction. The area has significant sport salmon and non-salmon fishing opportunities.

Wildlife in portions of the Skagit Wildlife Recreation Area in Skagit Bay and Port Susan possibly would relocate during construction to escape the noise and congestion in the Stanwood area. As a result, recreationists probably would not use part of the area during the construction phase. In 1978, approximately 24,000 visitor trips for hunting water fowl and 35,000 non-hunting visitor trips occurred in the area.

Operation

Normal operation of the pipeline would cause few impacts to area recreationists. Off-road vehicle operators probably would find the additional access roads and right-of-way inviting.

A pipeline leak would degrade water supplies upon which wildlife and park areas are dependent. Contamination of the Elwha or Skagit Rivers would be considered a serious impact Washington's attempt to protect these two rivers by special management criteria.

An underwater pipeline rupture and resulting oil spill between Whidbey Island and the Olympic Peninsula could cause extensive damage to all resources. Recreational shoreline parks on Indian Island at Oak Harbor (use unknown) and Mystery Bay (65,302 visits in 1978) could be affected for the season, as could the many parks on Whidbey Island and San Juan Islands. An extensive oil spill could affect a minimum of three million recreationists in the Central Puget Sound vicinity.

Abandonment

Impacts would be similar to those occurring during construction.

Table 8.4.3-37 summarizes the impacts resulting from construction, operation, and abandonment of TCM's proposed pipeline.

TABLE 8.4.3-37 SUMMARY OF ANTICIPATED IMPACTS TO RECREATIONAL ACTIVITIES

Recreational Activity	Impacts
Pleasure Driving	Construction and abandonment activities would detract from the aesthetic and natural qualities and result in a permanent visual intrusion. Temporary highway disruption during construction and abandonment phases would affect unknown numbers of drivers in local areas near construction or abandonment activities.
Off-Road Vehicle Use	Four-wheel drive, dirt bike, and snowmobile operation occur in designated and other suitable areas and would be temporarily disrupted by construction and abandonment. The presence of a right-of-way would probably encourage use along the corridor. Erosion and wildlife harrassment generally accompanies this activity and would indirectly affect recreationists participating in activities dependent upon wildlife.
Boating	Boating includes all forms of water travel for recreation: sail, motorized, canoe, or river rafts. Construction and abandonment activities may result in some decreased water quality or congestion on marine waters during pipelaying. The most important impact would occur during operation if there were a major oil leak or spill. Oil fouling of gear and boats as well as temporary loss of visual quality would inhibit recreational boating.

TABLE 8.4.3-37 (Continued)

Recreational Activity	Impacts
Marine Related Activities	Marine related recreational activities include crabbing, shellfish collecting, and beach combing. Oil leaks or spills may cause critical short-term and possible permanent damage to crab and shellfish resources. Beach areas would recover slowly, especially in rocky intertidal areas not frequently flushed by wave action.
Water Play	Water play activities include informal uses such as swimming, beach combing, inner tubing, or scuba diving. During operation, an oil leak or spill would detract from the area's desirability for water play activities. Over 400 shoreline parks are found along the Strait and Sound.
Forest Related	Forest-Related activities include informal, dispersed uses of forested areas. Mushroom collecting, berry picking, or wood collecting are some examples. Disruption of these activites would occur during construction and abandonment.
Hunting and Fishing	Hunting and fishing activities could be temporarily disrupted during pipeline construction or abandonment. These operations could limit access to preferred areas. Wildlife and fish would probably leave the immediate area during construction activities. Major oil spills on land or in the water could adversely affect these activities in the area impacted by the spill and associated cleanup operations. There could be long-term impacts on hunting/fishing availability, success, desirability, and opportunities.

Hunting and fishing activities could be disrupted temporarily during pipeline construction and abandonment. These operations could limit access to preferred areas. Wildlife and fish probably would relocate. Major oil spills on land or water could adversely affect hunting and fishing in the area impacted by the spill and associated cleanup operations. There could be long-term impacts on hunting and fishing availability, success, desirability, and opportunities.

Fisheries

Construction

Harvests of shellfish and bottomfish would be reduced as a result of submarine pipeline construction activities in the vicinities of Oak Bay, Marrowstone Island, Bush Point, Holmes Harbor and Saratoga Passage. Economic losses would persist for several years until populations recovered to pre-project levels.

Operation

An oil spill in a stream supporting salmon could have significant impacts on salmon production of that stream. An oil spill which reached the marine environment could have significant impacts as discussed previously in the Marine Resources section.

Abadnonment

No impacts from project abandonment have been identified.

Population

Construction

Temporary population increases resulting from construction activity might amount to as much as twice the number of construction workers estimated to be lodged or residing in a county as calculated below under Industry and Employment. In Skagit County the increase might be significant if it occurred in conjunction with peak construction activity on the Skagit Nuclear Project. Population increases in other counties would not be significant.

Operation

No impacts on population have been identified.

Abandonment

No impacts on population have been identified.

Industry and Employment

Construction

Table 8.4.3-38 shows the estimated distribution of the construction work force by work location. The table omits the work force residing in Clallam County. The land pipeline work force of 334 workers was assumed to progress from the terminal storage site to the Canadian border at a uniform rate during the scheduled construction period. Workers would tend to lodge within commuting distance of the work site roughly in proportion to the distribution of population and community facilities in the area. The estimated percentage distribution of the work force by lodging place

TABLE 8.4.3-38 CONSTRUCTION WORK FORCE BY WORK LOCATION

County and facility	Year 1 J 1	F 2	M 3	A 4	M 5	J 6	J 7	A 8	S 9	O 10	N 11	D 12	Year 2 J 1	F 2	M 3	A 4	M 5	J 6	Percent distribution for lodging[1] Jeff-erson	Is-land	Sno-homish	Ska-git	What-com
Jefferson:																							
Land pipeline[2]		7	7	50	50	50	50	40											100				
Pump station		5	5	5	10	23	23	23	23	23	10	5	3						100				
Marine crossing[3]										75	75	75	15						100				
Total		12	12	55	60	73	73	63	23	98	85	80	18										
Island:																							
Land pipeline								68	334	131										25	50	25	
Marine crossings[3]										54	75	75	135	150	150					50	50		
Total								68	334	185	75	75	135	150	150								
Snohomish:																							
Land pipeline										203											50	50	
Skagit:																							
Land pipeline											334	334	124								25	50	25
Pump station		5	5	5	10	23	23	23	23	23	10	5	3									100	
Total		5	5	5	10	23	23	23	23	23	344	339	127										
Whatcom:																							
Land pipeline													210	334	334							10	90

[1] Shows allocation of facility work force working in county among counties within commuting distance for lodging purposes.
[2] The land pipeline work force in Jefferson County represents 15 percent of the pipeline force in Clallam and Jefferson Counties combined.
[3] The work force for the marine crossings was estimated to total 150 workers.

is shown in the table for each work location. Table 8.4.3-39 shows the number of construction workers expected to be lodged in each county as derived from table 8.4.3-38.

Additional employment would occur in these counties as a result of construction workers expenditures and the procurement purchases of contractors but these impacts are not considered significant.

Operation Phase

No impacts were identified for this phase.

Abandonment Phase

No impacts from project abandonment were identified.

Income

Construction Phase

No impacts were identified.

Operation Phase

Power costs to local users in Jefferson and Skagit Counties might be adversely affected in the same manner as those for Clallam County as described in the Transportation and Utilities section.

Abandonment Phase

No impacts were identified from abandonment of the project.

Fiscal Conditions

Construction Phase

Sales tax revenues resulting from construction activity are shown in table 8.4.3-40. Sales tax would apply to the value of construction contracts at the construction site. Sales tax revenues would also accrue from the expenditures of workers and from other expenditures induced by construction activity.

Local government expenditures generally would be minor. Significant impacts on local budgets could be incurred where road repair costs were substantially in excess of increased revenues. These costs are considered indeterminable because their magnitude would be affected by enforcement of road regulations, collection of reimbursable amounts, and weather conditions.

State government revenues and expeditures resulting from the project are considered insignificant impacts to the state.

TABLE 8.4.3-39 CONSTRUCTION WORK FORCE BY LODGING PLACE

	Year 1												Year 2					
County	J 1	F 2	M 3	A 4	M 5	J 6	J 7	A 8	S 9	O 10	N 11	D 12	J 1	F 2	M 3	A 4	M 5	J 6
Jefferson		12	12	55	60	73	73	63	23	98	85	80	15					
Island								17	84	60	38	38	68	75	75			
Snohomish								34	167	194	121	121	98	75	75			
Skagit		5	5	5	10	23	23	40	106	157	177	172	86	33	33			
Whatcom											83	83	220	301	301			

Note: Derived from table 8.9.3-38.

TABLE 8.4.3-40 SALES TAX REVENUES, CONSTRUCTION PHASE
(Thousands of dollars)

	Construction Expenditures		Personal Income		Total Tax
	Rate	Amount 1/	Rate 2/	Amount	Revenue
Local taxes					
Clallam	0.5	$ 106,602	0.156	$ 27,900	$ 577
Jefferson	0.5	15,756	0.156	2,270	83
Island	0.5	20,489	0.156	1,590	104
Snohomish	0.5	3,715	0.156	3,100	24
Skagit	0.5	17,411	0.156	3,060	92
Whatcom	0.5 3/	16,188 3/	0.250	3,460	92 3/
Washington State tax	4.6	180,161	2.083	41,380	9,149

1/ Taxable construction includes contingencies but excludes company expenditures for environmental studies, engineering, and management (and sales tax) all not subject to sales tax. Taxable construction expenditures are subject to tax at place of use rather than place of sale. Expenditures for the land and marine portions of the main pipeline were separately allocated on the basis of mileage.

2/ Represents effective rate after allowance for portion of income spent locally and subject to tax.

3/ The City of Bellingham levies an 0.8 percent tax, and about 1 mile of the pipeline lies within the city limits. County consumption expenditures are assumed to occur entirely in Bellingham. Revenue to Bellingham would amount to about $13,000 out of the total shown for Whatcom County.

Operation Phase

Property taxes on the new facilities during the first year of operation are shown in table 8.4.3-41. These estimates are based on county-wide averages and only approximate the actual taxes which might be due. The assessed value (also shown) shows the increase in tne property tax base in the initial year. The assessed value of the pipeline exclusive of major facilities would amount to about $518,000 per mile over the 148-mile route in Washington in the initial operating year. All facilities including the marine crossings over public lands would be subject to tax. The assessed value in subsequent years would be determined on an income valuation basis and would be subject to depreciation. Assessed value and taxes in subsequent years would probably be substantially lower. These increases are not considered significant.

Additional expenditures of local governments would be minor.

Abandonment Phase

Revenue incurred during operation would be lost.

Infrastructure

Operation of the pipeline system in Clallam County will provide 66 jobs (11 for local residents and 55 for non-local persons). Indirect employment will provide about 53 jobs for local residents and 50 jobs filled by new arrivals. The total in-migration will not have a significant impact on infrastructure components such as housing, public utilities, schools, medical services, police/fire protection, social services, government.

Twenty-three miles of the proposed pipeline will pass through Island County. At an estimated one-half mile per day construction rate, 46 days will be needed for construction. It is estimated that no more than 630 persons (non-local employees and families) will seek housing at any given locale during construction.

With a housing unit total of 8,693, and a vacancy rate of 8 percent, there was about 695 vacant housing units on Whidbey Island in 1977. About 40 percent of these, or 280, would be rental units. In addition, the Oak Harbor/Coupeville area had 99 motel units and 29 camper-trailer spaces in 1977.

During the construction period housing availability will be strained. Although annoying, this short-term impact will not be significant.

Construction activities will temporarily create dust, noise, traffic delays, and congestion. No significant adverse impacts on the infrastructure components on Whidbey Island are expected.

Since the proposed pipeline system parallels the existing TMC right-of-way through Skagit and Whatcom Counties its construction and operation is not expected to have significant adverse impacts on existing or future infrastructure components.

Social Well-Being and Quality of Life

In general, implementation of the proposed project will not adversely impact social well-being or quality of life indicators for residents of the affected counties. But neither will it have any significant beneficial impacts. Some Whidbey Island residents oppose the proposed project. In essence, they see no potential benefits and therefore conclude that the risks (potential spills) could adversely affect their quality of life.

Because the proposed pipeline system will not cross the Tulalip, Swinomish, or Lummi Reservations the effects of construction and operation will be minimal--no significant adverse impacts will occur on the infrastructure components or indicators of social well-being and quality of life. These tribal groups, however, oppose the proposal due to potential to retard the planned expansion of tribal fishing operations.

TABLE 8.4.3-41 PROPERTY TAXES
(Thousands of dollars, estimates for first year of operation without allowance for depreciation in subsequent years)

	Pipeline Mileage[1]	Pipeline Value	Facility Value[2]	Total Value	Assess Ratio[3]	Average Levy	Assessed Value	Property Tax
Clallam	44.0	$ 29,528	$ 94,559	$124,087	73.2	15.49	$ 90,832	$ 1,407
Jefferson	16.5	11,073	3,060	14,133	82.2	14.06	11,617	163
Island	22.5	15,099	--	15,099	76.0	14.16	11,475	162
Snohomish	7.0	4,698	--	4,698	85.4	16.36	4,012	66
Skagit	27.5	18,455	3,060	21,515	80.9	15.72	17,406	274
Whatcom	30.5	20,468	--	20,468	77.2	14.48	15,801	229
	148.0	$ 99,321	$100,679	$200,000				

Source: BLM

Note: Property taxes were computed on the basis of estimated construction costs. Major facilities including pump stations were assigned to the county in which located. Pipeline value was distributed on a direct mileage basis on the presumption that all of the throughput would be delivered to points outside Washington.

[1] All pipeline mileage including marine crossings would be subject to property taxes.

[2] Includes pump stations valued at $3,059,000 in Clallam County, and $3,060,000 each for the other two stations.

[3] Assessment ratios for 1979 differ slightly from the 1978 ratios used in computing property taxes for Northern Tier proposal.

8.4.4 MITIGATING MEASURES

Measures which could reduce the impacts identified in Chapter 3 are addressed in this chapter as possible mitigating measures. See table 8.4.4-1.

Most impact reducing measures proposed by the applicant are, in fact, design features, construction-reclamation methods, or operating procedures, which are discussed in chapter 1. Federal and state agencies and private landowners could require additional measures as conditions to permits and easements.

Available information on the proposal addresses the pipeline route in terms of a two-mile wide corridor. The port and onshore storage facilities and the pipeline are addressed in terms of preliminary design criteria. Federal, state, and local agencies require more specific information on proposed locations, design of system components, construction schedules and methods, reclamation methods, and operating procedures to determine what mitigating measures would be required. Private landowners also need site-specific details on the proposal in order to determine what measures they would require as easement provisions.

For those reasons, the possible mitgating measures contained in this chapter should not be considered all-inclusive.

The possible mitigating measures that follow address only significant impacts identified in chapter 8.4.3. They are considered reasonable, enforceable measures which might be included as terms and conditons to permits, easements, or right-of-way grants issued by private individuals, and local, state,, or federal agencies, should the TMC proposal be approved.

8.4.5 ANY ADVERSE IMPACTS THAT CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

This section identifies, summarizes, and where possible quantifies significant unavoidable adverse impacts that would occur if the proposal were implemented. These include impacts which are not amenable to mitigation, and therefore are unavoidable. Other impacts are susceptible to varying degrees of mitigation. It is assumed that possible mitigating measures in 8.4.4 would be implemented.

AIR QUALITY

Construction Phase

During construction of the proposed port and onshore storage facilities there would be temporary emissions of nitrogen oxides, carbon monoxide, hydrocarbons sulfur dioxide, and particulates from construction equipment. There would also be fugitive dust emissions at the site of the proposed onshore storage facilities. These impacts would be temporary and confined to the immediate vicinity of the project site.

TABLE 8.4.4-1 POSSIBLE MITIGATING MEASURES

Mitigating Measure	Effectiveness	Environmental Component
Locate mainline stations at least 2500 feet from noise sensitive receptors.	Prevent noticable increase in noise levels and annoyance at these locations.	Noise
Route pipeline away from potential landslide areas or use stronger pipe through them.	Eliminate or reduce to undetermined degree the risk of pipe failure and oil spill due to landslide.	Topography-Geology
Water sprinkle disturbed soils during construction.	50 - 90 percent effective in eliminating soil loss.	Soils
Limit construction across streams to specific time periods.	Nearly 100 percent effective in preventing mortalities to some fish species in protecting irrigation uses.	Aquatic Resources
Limit time, rate, location of test water withdrawal and discharge.	Nearly 100 percent in preventing fish mortality, meeting minimum flow requirements, preventing scouring and insuring quality irrigation water.	Aquatic Resources
Place block or check valves at stream crossings in addition to those specified.	Up to 100 percent effective in reducing oil reaching stream in event of a spill.	Aquatic Resources
Clear flood debris from stream at crossings.	Up to 100 percent effective in reducing accelerated scour and possible pipe breaks.	Aquatic Resources
Divert flow around construction area in large streams and/or use barge onshore storage of spoil.	Reduce stream siltation to undetermined but significant amount.	Aquatic Resources

TABLE 8.4.4-1 (Continued)

Mitigating Measure	Effectiveness	Environmental Component
Locate precisely and route submarine pipelines around valuable clam and oyster beds.	Up to 100 percent effective in protecting shellfish resources.	Marine Resources
Establish vegetative screen where right-of-way crosses trails and scenic travel ways.	Up to 100 percent effective in reducing visual intrusion of right-of-way.	Visual Resources Recreation
Create physical barriers to vehicles on pipeline access roads and national trails.	Undetermined effectiveness in eliminating recreation vehicles from rights-of-way, contributing to soil erosion and conflict with other recreationists.	Soils Recreation
Designate special camping areas for construction crews.	Reduce demands on existing camping facilities and housing to undetermined extent.	Recreation Social
Route pipeline to avoid drain tile in agricultural areas or modify existing drainage systems to ensure proper drainage.	100 percent effective in preventing drainage problems on agricultural lands.	Land Use
Provide field medical personnel during construciton.	Undetermined reduction on demands on local medical facilities.	Social
Require appropriate agency approval for location and design of access roads.	Reduce damage to existing roads and insure compliance with plans and ordinances to undetermined degree.	Transportation Land Use

TABLE 8.4.4-1 (Continued)

Mitigating Measure	Effectiveness	Environmental Component
Locate borrow areas away from roads and public use areas.	Up to 100 percent effective in reducing public exposure to such areas.	Visual
Provide electrical grounding of pipe and equipment near power lines during construction.	Reduce electrocution hazard to workers to undetermined degree.	Utilities
Maintain adequate clearances between energized conductors and men and equipment.	Undetermined but significant effectiveness in reducing electocution hazard to workers.	Utilities
Conduct surveys for cultural resources prior to and during construction.	Up to 100 percent effective in providing opportunity to avoid destruction of or recover data from cultural resources.	Cultural
Revegetate right-of-way with species beneficial to wildlife.	Up to 100 percent effective in preventing loss of wildlife food species in disturbed area.	Wildlife
Require payment of incremental power costs.	Up to 100 percent effective in preventing increased power costs caused by the project to other customers.	Utilities Economics
Implement road monitoring and management program with current reimbursement for road damage.	Significantly effective in collecting reimburseable costs of road repair by local agencies	Economics

Operation Phase

Some increase in pollutant concentrations over the Low Point area would be unavoidable. A future modeling study would determine the degree of air quality degradation. In the absence of meterological data in the Low Point area, no quantitative determination can be made of air quality impacts.

Abandonment Phase

Impacts of abandonment operations would be similar to those associated with construction. Impacts on air quality would be temporary and confined to the immediate vicinity of the abandonment site.

NOISE

Construction Phase

Unavoidable noise impacts resulting from construction of the port, submarine pipelines, and storage facilities at Low Point would be experienced by campers in the Lyre River Campground and a few rural residences. These impacts would be short-term and temporary.

Operation Phase

An increase in noise would occur during the operation of the port facilities. The primary source of this noise would be the electric pumps at the onshore storage facilities. The maximum noise level at 100 feet would be about 64 dBA (TMC 1979).

Abandonment Phase

Noise resulting from abandonment procedures would be similar to noise resulting from construction procedures.

TOPOGRAPHY AND GEOLOGY

Construction

Suggested mitigtion measures in Chapter 8.4.4 would prevent significant unavoidable impacts during construction.

Operation

A large magnitude earthquake could generate groundshaking strong enough to break components of the port and onshore storage facilities, causing an oil spill or fire. This impact cannot be mitigated.

Potential landslide along the coastal bluff with potential breaks in the system could be fully to partially mitigated as indicated in 8.4.4.

Abandonment

There would be no signifcant unavoidable adverse impacts.

SOILS

Construction Phase

There would be a small but significant amount of soil loss from fugitive dust emissions at the Low Point site during construction. The loss of soil due to erosion is expected to be less than one ton per disturbed acre. This would be equal to about .007 inches of topsoil, and is not significant.

Operation Phase

Wind and water erosion would be stabilized to near zero during the operation phase.

Abandonment Phase

During abandonment, impacts similar to those for construction would occur.

AQUATIC RESOURCES

Physical Components

Construction Phase

During moderate to heavy rainfalls there would be an increase in runoff and erosion from exposed soils. Only slight increases in the amount of sediment reaching Murdock and Susie Creeks and the Lyre River would be expected, temporarily increasing turbidity.

Shallow ground water tables, if present, may be lowered or removed by leveling and earthwork activities.

Hydrostatic testing would temporarily decrease stream flows.

Operation Phase

Since much of the project site would be covered with surfaces and structures that are impermeable, recharge to near-surface ground water and subsequent ground water flow to nearby streams would be reduced slightly.

Oil spills during operation could adversely impact nearby streams and near-surface ground waters if oil escaped from containment areas.

Abandonment Phase

Removal of the onshore facilities would result in similar sediment impacts as described for the construction phase.

Biological Components

Construction Phase

If minor amounts of sediment reach nearby streams, it could lead to siltation of spawning areas and cause minor temporary reductions in fish populations.

Operation Phase

A major oil spill that escaped containment could reach the local streams causing significant reductions to fish populations and other aquatic resources present at the time of the spill.

Abandonment Phases

Only minor temporary reductions to fish populations would be expected during the abandonment phase caused by siltation of spawning areas.

MARINE RESOURCES

Physical Components

Construction Phase

Construction activities offshore of Low Point would temporarily disturb fine-grained sediments creating turbid water conditions in the Strait. These sediments could contain absorbed heavy trace metals, chlorinated hydrocarbons, and mineralized nutrients. A muddy bottom composed of fine sediments would be created within the near-shore small boat moorage facilities.

Operation Phase

Port operations would create unavoidable adverse impacts of varying degrees off Low Point and in the Strait from Cape Flattery to Low Point.

Chronic oil spills from tankers in-transit and at-berth (SPM's) would increase concentration of dissolved hydrocarbons in the seawater. Spilled oil not recovered would release soluble hydrocarbons and possibly trace metals associated with crude oil into the marine environment. The water quality of the surface, near-surface and, to a lesser degree, deeper water could be degraded.

A tanker casualty, with maximum credible loss or complete loss of cargo, in the Strait of Juan de Fuca would have an adverse, unavoidable, international impact on inland and coastal water quality.

If mechanical means were used to clean up oiled beaches after a tanker casualty, the shoreline equilibrium could be upset. Excess removal of beach material could cause erosion unless the removed material is replaced in kind.

Abandonment Phase

No unavoidable adverse impacts are expected in removing the two single point moorings.

Biological Components

Construction Phase

No major unavoidable impacts would result from the proposed construction.

Operation Phase

Tank vessel and small boat operations at Low Point may cause permanent alteration in patterns of use of Low Point by harbor seals and river otters, as well as other marine-oriented mammals and birds. The anchors, support chains, and buoys, as well as the breakwater, would support "fouling" communities with many components of rocky habitats. These communities would provide food and shelter for some fish species.

A large to catastrophic oil spill at Low Pont or in the Strait of Juan de Fuca would have major unavoidable impact upon the marine biological resource. Precise quantification would depend on many factors. Chronic small oil spills would have minor unavoidable adverse impacts.

Abandonment Phase

No major unavoidable impacts would result from abandonment of the proposal.

Chronic small crude or fuel oil spills that escape containment and infrequent larger spills would have unavoidable adverse biological impacts as described earlier.

TERRESTRIAL VEGETATION

Construction Phase

Loss of vegetative cover on the 300 acre storage site at Low Point could not be mitigated and would be a regionally minor unavoidable impact.

Removal of vegetation from Low Point would expose the surrounding timber to wind damage.

Operation Phase

The potential escape of a large oil spill or fire from the confines of the storage facility would potentially affect significant areas of nearby forest, riparian, coastal, and pastureland vegetation adjacent to the facilities.

Abandonment Phase

No unavoidable impacts should persist from abandonment of the project.

TERRESTRIAL WILDLIFE

Construction, Operation, and Abandonment Phases

At the onshore storage facilities approximately 300 acres of mixed-woodland, agricultural, and "edge" habitat would be unavoidably lost to area wildlife for the duration of the project.

CULTURAL RESOURCES

Construction, Operation, and Abandonment Phases

The two documented prehistoric sites found at Low Point would be permanently removed from the resource base.

Any archeological resources not identified before construction, but discovered in the course of construction activities, might be partially destroyed.

VISUAL RESOURCES

Construction Phase

Constructlon of the onshore storage facilities would cause unavoidable visual disruption of the existing character of the site. The storage tanks or portions of them would be visible offshore in the immediate vicinity of the site, and in some upland areas to the south. The submarine pipeline ascending to the onshore storage facility is assumed to be accomplished by clearing and trenching up the bluff, resulting in a permanent scar in full view of vessels in the Strait of Juan de Fuca; it would be an unavoidable visual intrusion that would exist far beyond the life of the project.

Operation Phase

The SPMs and tankers moored to them would be visible from areas along the coast of the Strait of Juan de Fuca. This would be visually offensive to some people.

Major oil spills would make the surrounding area unattractive immediately following the spill and during cleanup operations.

Abandonment Phase

No further adverse visual impacts would result from abandonment.

LAND USE

Construction Phase

The most significant impact of the proposed port and storage facilities would be the dislocation of 3 households and loss of the pastureland and woodland that are presently located on the onshore storage facility site.

Operation Phase

The major impact associated with the facility would be the change from forest, pasture, and low-density residential to an intensive use industrial site.

Adjacent land uses would be adversely affected by a large oil spill, explosion, or fire at the port or onshore storage facilities.

Abandonment Phase

The process of abandonment would be a nuisance to adjoining land uses, similar to construction activity.

TRANSPORTATION AND UTILITY NETWORKS

Construction Phase

A substantial increase in the number of vehicles using nearby roads and highways would inevitably result from construction and abandonment of the facilities at Low Point.

Operation Phase

Increased tanker traffic and the location of moored tankers in the Strait of Juan de Fuca would result from operation of the terminal facility, resulting in minor unavoidable adverse impacts.

The Clallam County Public Utility District may experience shortfalls in its firm energy supply beginning in 1983. The electric power requirements for project operation might aggravate a potential power supply shortage in the area served by the District.

Abandonment Phase

No significant adverse impacts to transportation or utility systems are likely to occur.

RECREATION

Construction Phase

The tanker unloading facilities, tankers moored offshore, and the onshore storage facilities would be visible from nearby recreational areas; desirability of these areas however would be reduced as a result of construction activities and changed use of area.

Sport fishing and recreational boating would be disrupted in the areas near the tanker unloading facilities.

Operation Phase

A major oil spill would affect recreational resources in the area, for an indeterminate length of time depending on magnitude of spill and success of clean up efforts.

Abandonment Phase

Impacts would be similar in type and degree to those occurring during the construction phase.

ECONOMIC CONDITIONS

Construction Phase

There would be temporary significant adverse impacts from crowding, loss of transient housing, and increased cost of living.

Operatiuon Phase

Large oil spills would have significant adverse impacts on fishery and recreational economics, and land values.

Abandonment Phase

There would be a reduction of property taxes over those incurred during project operation.

SOCIAL CONDITIONS

Construction Phase

There would be minor adverse impact to the school system, and to the adequacy of the low enforcement and fire protection agencies.

Operation Phase

There would be minimal impact to the school system, and to existing inadequacies of law enforcement agencies.

There would be significant short term impacts to quality of life for Clallam Co., and to quality of life and social well being for the Makah and Elwa Native American Reservations.

Abandonment Phase

No adverse impacts would result from project abandonment.

PIPELINE SYSTEM

AIR QUALITY

Construction Phase

Construction of the pump stations and pipeline would result in minor temporary, localized emissions of fugitive dust and combustion products.

Operation Phase

No adverse impacts would be expected during operation of the pipeline and electric pump stations.

Abandonment Phase

Impacts of abandonment operations would be similar to those associated with construction. Impacts on air quality would be temporary and confined to the vicinity of the abandonment site.

NOISE

Construction Phase

Construction of the pipeline would cause temporary high noise levels at nearby rural residences and outlying residential zones along the route.

Operation Phase

Noise increases would be generated from the operation of the pump stations at Fairmont and Burlington. These increases would be experienced by only a few rural residences. The maximum noise level at 100 feet would be about 64 dBA (TMC 1979).

Abandonment Phase

Abandonment procedures would cause temporary noise increases similar to those generated by construction activities.

TOPOGRAPHY AND GEOLOGY

Construction Phase

Unquantifable adverse impacts could occur if the pipeline is routed through unstable slopes.

Operation Phase

Occurrence of large earthquake could cause an oil spill by breaking the pipeline. Impacts could be minor to major depending upon the location and magnitude of the event.

Liquefaction could break the pipe causing a spill. Magnitude of impacts would depend on circumstances of event.

A landslide could occur in unstable areas, breaking the pipe, and causing an oil spill. Magnitude of the impact would depend on circumstances of the event.

Abandonment Phase

No significant impacts would occur from abandonment.
Natural soil profiles within the pipe trench would be lost forever. This would amount to about 70 acres.

Operation Phase

An oil spill or pipeline leak would have impacts ranging from a slight nuisance to catastrophic depending upon variable factors of leak size, soils, topography, and temperature. Soil productivity could be lost for up to 10 years.

Abandonment Phase

When the pipeline is salvaged, impacts similar to those for construction of the pipeline would occur.

AQUATIC RESOURCES

Physical Components

Construction Phase

Runoff and sedimentation from instream trenching would occur during construction and would temporarily degrade water quality at stream crossings. Fuel oil and chemical spills during construction activities would adversely affect water quality. Near-surface ground water would be displaced during constructlon of the pipeline trench.

Stream flows would temporarily decrease when water is withdrawn for hydrostatic testing of the pipeline and temporarily increase when water is returned to the stream. These are unavoidable temporary minor impacts.

Operation Phase

Oil-spill potential exists. The severity of the impact would depend on the amount of oil spilled, time before oil containment, topography of the area, volume of river flow, and time of year.

Oil-spill impact on ground water would depend on location and volume of oil spilled, depth to water table, water table gradient, and permeability of subsurface materials. Shallow aquifers would be most vulnerable.

Abandonment Phase

No significant adverse impacts are anticipated.

Biological Components

Construction Phase

Low to moderate temporary reductions in salmon and trout populations would result from increased sedimentation in streams.

Spills of fuel oil or other chemicals into streams during construction would decrease fish and aquatic insect populations downstream from the spill site. Full recovery could take several years.

Operation Phase

In the event of a large, uncontained oil spill salmonid populations could be reduced for several miles downstream and contamination from residual materials could continue for several years.

Impacts may be noticed in sport or Indian river fisheries, particularly after a large spill which could eliminate large numbers of one or more year-classes of an important salmonid species.

Abandonment Phase

Adverse impacts for the abandonment phase would be expected to be similar to those described above for the construction phase but of lesser magnitude.

MARINE RESOURCES

Physical Components

Construction Phase

Temporary degradation of the water quality in Admiralty Inlet and Saratoga Passage would occur during installation of the submarine pipelines. Bottom sediments would be disturbed and concentrations of suspended material in the water column would increase. Burial of the pipeline at major river crossings would introduce additional suspended sediments into nearby estuaries. These sediments could contain anaeobically decomposed organic matter, pulp mill and domestic sewage sludges, organically bound or mineralized nutrients, soluble, precipitated, and particulate absorbed trace metals, chlorinated hydrocarbons, and petroleum hydrocarbons. Suspension of these sediments could temporarily increase chemical and biochemical oxygen demands which would depress the dissolved oxygen levels.

Operation Phase

A large oil spill from a submarine pipeline rupture in Admiralty Inlet or Saratoga Passage could probably not be contained in time to avoid oiling beaches. The soluble petroleum fractions would severely degrade water quality in Puget Sound, Hood Canal or within the Whidbey Basin. Significant oil spill at river crossings of river would severely impact its estuary and degrade marine water quality, within and seaward of the estuary.

Abandonment Phase

No adverse impacts are anticipated.

Biological Components

Construction Phase

No significant unavaoidable impacts are anticipated.

Operation Phase

An oil spill could cause moderate to major unavoidable impacts to shellfish, finfish, marine birds and mammals, and marine and estuarine vegetation. The degree of impact would depend upon the circumstances of the spill..

Abandonment Phase

There would be no adverse unavoidable impacts from abandonment.

TERRESTRIAL VEGETATION

Construction Phase

Clearing of 1,585 acres of vegetation would occur along the corridor. An unidentified amount of marketable timber would be cut and sold.

Operation Phase

Repair and maintenance vehicles travelling the corridor would cause further soil compaction which would inhibit plant growth.

In the event of an oil spill, large or small, a certain amount of vegetation would be destroyed. The significance of this would depend on circumstances of the spill.

TERRESTRIAL WILDLIFE

Construction Phase

Disturbance of wintering peregrine falcons near Burlinton could reduce this habitat. During construction there would be an unavaoidable short-term habitat loss to resident wildlife along the pipeline right-of-way. Bald eagle nesting populations on Marrowstone Island would be disturbed and possibly displaced.

Disturbance of waterfowl resting and rearing areas could reduce populations for one year.

Operation Phase

Major oil spills could cause moderate to major adverse impacts on terrestrial habitat, terrestrial wildlife, and migratory birds. The degree of impact would depend on the circumstances of the spill.

Abandonment Phase

There would be no significant adverse impacts from abandonment.

CULTURAL RESOURCES

Construction, Operation, and Abandonment Phases

Some cultural resource sites along the pipeline might not be identified during the precontruction surveys. Some damage could occur at such sites before materials were recognized.

VISUAL RESOURCES

Construction and Operation Phases

There would be short-term visual impacts during construction.

Unavoidable adverse visual impacts from construction and operation of the pipeline would occur where the pipeline right-of-way ascends and descends the coastal bluffs on both sides of Admiralty Inlet and Saratoga Passage. The extensive scars would be visible to vessels traversing these waterways.

Removal of pump stations and removal of the pipeline (except for major waterway, bluff installation, and highway crossings), would result in short-term visual impacts similar to those caused during construction.

LAND USE

Land uses and areas that would be unavoidably impacted are shown in Table 8.4.5-1.

TABLE 8.4.5-1 UNAVOIDABLE IMPACTS--LAND USE (ACRES)

Type of Land Use	Area Disturbed by Construction/Abandonment Operation	Permanent Right-of-Way for Pipeline System
Urban	36	27
Agriculture/Grassland	679	509
Forest/Woodland	945	709
Other	145	109
Subtotal	1805	354
Electric Service	unknown	unknown
Storage Yards	unknown	unknown
Borrow Spoils	unknown	unknown
Total	unknown	unknown

Construction Phase

Significant unavoidable impacts to land use during construction include temporary disruption to adjoining land uses and nuisance impacts of dust, noise, visual disharmony, and potential traffic delays. Nuisance impacts would be most severe along the approximate 36 acres of the route that passes through urban fringe areas.

Across agricultural lands, construction activity would preclude production for at least one season on approximately 680 acres of cropland and improved pasturelands. The subsequent years productivity might be reduced by 5 to 10 percent.

About 945 acres of forest and woodland would be cleared during construction, resulting in a one time harvest of wood products.

Operation Phase

Significant impacts to land use might occur as a result of an oil spill and subsequent reclamation activity. The severity of impact would depend upon the circumstances of the spill.

Pipeline system operation through urban areas would preclude erection of improvements and development for other intensive uses within the permanent right-of-way. Areas near the right-of-way would be exposed to the risk of oil spill, fire and explosion damage. Major pipeline repair would result in nuisance impacts similar to that incurred during construction.

Abandonment Phase

Abandonment of the pipeline would cause impacts similar to those incurred during construction.

TRANSPORTATION AND UTILITY NETWORKS

Construction Phase

Project-related vehicles and construction activity would cause temporary traffic delays at some road and highway crossings. Truck traffic might cause significant amounts of wear on local roads.

Construction activity might damage nearby utility systems. The probability of this occurring is significantly reduced by the various crossing and joint use permits required; however, the safety of other nearby systems would still be subject to damage by human error.

Operation Phase

Oil spills could disrupt nearby transportation and utility networks, especially during cleanup activities.

Project operation would further aggravate possible regional power supply shortages.

Abandonment Phase

Upon project abandonment, transportation and utility facilities near the pipeline might be damaged during pipeline removal activities.

RECREATION

Construction Phase

There would be no significant unavoidable impacts.

Operation Phase

An underwater pipeline leak or rupture and resultant oil spill could cause considerable loss to marine-related recreation in central Puget Sound, effecting up to 3 million recreationists over a two-month period.

Abandonment Phase

There would be no significant impacts from abandonment.

SOCIAL CONDITIONS

Implementation of the proposed action would have no significant adverse impacts on social conditions.

8.4.6 THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRDUCTIVITY

For this discussion, the short-term is considered the 20-year economic lifetime of the project. The long-term is the period beyond 20 years during which impacts resulting from the project would continue.

The purpose of the proposed TMC project is to provide a means of transporting Alaskan and foreign crude oil from the west coast to the northern tier states. Construction and operation of the project would supply crude oil to be distributed to northern tier refineries which are currently experiencing deficits. These deficits are expected to increase in the future.

PORT AND ONSHORE STORAGE FACILITIES

Port Facility

The port facility would include two single point moorings and two 48-inch submarine pipelines extending about 2.5 miles to the onshore storage area. The single point moorings consist of a floating anchored buoy, mooring lines, and unloading hose lines to the submarine pipelines.

Harbor area sufficient for each single point mooring and adequate clearance for tanker maneuvering would be committed for the duration of the project. The amount of sea bottom necessary to anchor the buoys and to place the submarine pipelines would be temporarily disturbed.

Oil spills from tankers, fuel barges, submarine pipelines or the unloading facilities would degrade environmental resources in excess of those related to normal project operation. The cumulative results of chronic operation spills plus any major spill could cause indefinable residual adverse effects on marine water quality, and organisms, and shoreline, continuing into the long-term.

Onshore Storage Facilities

Implementation of the proposed project would commit about 300 acres of forest land at Low Point. The short-term use of this area would entail some long term commitments of environmental resources. The topography and soil of the site would be permanently altered, these changes would limit future uses.

Depending upon the construction method, the pipeline across the beach and bluff area would visually impact the area for the long-term.

PIPELINE SYSTEM

The pipeline route affecting about 1,000 acres of forest and agricultural land parallels existing corridors or rights-of-way for 77 percent of its length. Approximately 34 miles (206 acres) of previously undisturbed land would be committed. After construction, the land above the pipeline would be available for other uses. Forest areas cleared for the project would be lost for the life of the project.

In the long-term, removal of the pipeline would allow other uses of the land. The commitment of land resources generally would not affect either short- or long-term opportunities.

Construction and operation of the project would require short-term uses of environmental resources. None of the short-term uses is likely to have significant impacts on long-term maintenance of productivity of the resources. There will be local adverse impacts, generally of short duration, on air quality, aesthetics, noise levels, soils, terrestrial and aquatic biota, and local social and economic conditions.

Minor oil spills or pipeline leaks are expected during the life of the project. These would result in localized reductions of water or soil quality for short periods of time. Nearby marine or terrestrial plants and animals might also be adversely impacted. Such spills would require the commitment of local resources for a short time, but the area would return to prespill conditions within a few years. Long-term decreases in productivity are not expected.

A major oil spill or pipeline rupture is unlikely during the life of the project. If one did occur, the amount and significance of environmental damage would depend on time, place, and size of spill; ability to contain or clean up the spill; and life stage of plants and animals present. A major spill could affect many environmental resources. Impacts could be significant, but generally of relatively short duration. Changes in population densities and species distribution and diversity would occur following an oil spill. With time, these would probably return to conditions approximating those prior to the spill. In addition, there would be concomitant impacts on the portion of the economy dependent upon the natural resources. Some undefinable, but not severe, residual adverse effects on water quality and aquatic and terrestrial organisms would probably continue into the long-term.

Implementation of the project would incur the risks of fire and explosion resulting in undetermined property damage and loss of lives. These risks would be eliminated after abandonment of the project.

CUMULATIVE IMPACTS: POTENTIAL TO SUPPLY PUGET SOUND REFINERIES

Background

The issues of existing tanker traffic on Puget Sound and the possibility of development of a crude oil transshipment facility in Washington state waters have generated widespread interest and controversy in both legislative and public forums. As a result of these concerns former Washington Governor Daniel J. Evans added a policy statement to the Washington Coastal Zone Management Program indicating that the state "positively supports the concept of a single, major crude petroleum receiving and transfer facility at or west of Port Angeles," and that the facility "shall be designed to include provisions to supply existing refineries in Whatcom and Skagit Counties."

Present Governor Dixie Lee Ray has requested that the Department of Commerce delete this statement from the approved Washington Coastal Zone Management Program. A draft environmental statement considering such action was filed with EPA in November 1978.

Facilities

The TMC unloading, storing, and transporting facilities are designed to handle a maximum of 630,000 barrels per day of crude oil. There are no provisions in the proposal covered by this application under which this quantity could be increased. It is stated that, "should large volumes be required and sufficient use of an expanded system be guaranteed, Trans Mountain can expand the system proposed in this application as required to transport the additional volumes that may be nominated . . . ." (TMC 1979).

To provide crude oil to the Washington refineries cross-over connections would be required from the new 30 inch pipeline at Burlington leading to Anacortes, and at Laurel leading to Ferndale.

This proposal would provide a maximum of 630,000 barrels per day and presumably economic and political factors in future years would determine its distribution among Washington and northern tier refineries.

8.4.7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Consumption of finite resources in a manner which precludes their use for other purposes is termed an irreversible and irretrievable commitment of resources. This chapter summarizes those resources that would be consumed or otherwise lost for periods of time if the proposal were implemented.

Construction, operation, and abandonment of the proposed port and onshore storage facilities and pipeline system would result in the commitment of varied resources for varying periods of time. Many would be "used" for the short term, and the loss during that time would be irretrievable. However, the short-term loss may not be irreversible.

In addition to the commitment of resources because of construction, operation, and abandonment of the proposal, the possibility of oil spills must be considered. Oil spills would cause changes in the environment and would require commitment of capital, labor, material, and energy for cleanup. The extent would depend on frequency, time, place, and magnitude of the spill.

AIR QUALITY

Construction, Operation, and Abandonment

Air quality and visibility would be degraded during the life of the project in the immediate vicinity of the proposed port. No irreversible or irretrievable commitments of air quality along the pipeline route would be anticipated.

SOILS

Construction, Operation, Abandonment

Impacts to soils as a result of the proposed project would be minor. Development of the port facility would commit the soils of about 300 acres for the life of the project. Soil lost by wind and water erosion during construction and abandonment would be lost irretrievably.

During construction and abandonment of the pipeline, soils along the agricultural segments of the right-of-way would be lost to production for at least 1 year following each phase. Mixing of soil horizons, thus altering the existing natural soils and changing the physical, chemical, and biological characteristics that determine their productive capacity, cannot be avoided. Soil properties such as texture, structure, and organic content would be irreversibly altered. In addition, the natural soil profiles along the trenched area of the pipeline route (about 70 acres overall) would lose their identity.

Oil-Spill Risk Analysis

Soil productivity in the agricultural sections of the pipeline route would be lost up to several years in the event of a major oil spill.

AQUATIC RESOURCES

Construction, Operation, and Abandonment

Construction and abandonment of the onshore storage facility at Low Point could result in alteration of localized shallow aquifers. Such impacts to ground water are not expected to influence surface waters and aquatic resources significantly.

Pipeline construction, particularly at stream crossings, would temporarily degrade water quality of numerous streams. There also could be a loss of fish production from streams which would be irretrievable as a short-term loss. Fish production would return to previous levels.

Oil Spill Risk Analysis

A major oil spill affecting aquatic resources could lead to an irretrievable loss of resources. At certain critical times and places, an oil spill could result in a loss of one or more year-classes of salmonids in certain streams, constituting an irretrievable loss of fishery resources.

MARINE RESOURCES

Construction, Operation, and Abandonment

Benthic organisms would be lost during construction. However, this loss would not be irreversible since benthic organisms would repopulate the new substrate. Construction of the pipelines, single point moorings and small boat moorage would result in a short-term degradation of water quality.

Oil-Spill Risk Analysis

Chronic, small-scale spills of crude or fuel oil would result in a reduction of water quality, and could also lead to a loss of marine life in the immediate area.

A major spill would cause significant degradation of marine water quality. A large spill could also cause irretrievable loss of marine life; however, that loss would probably be replaced over the long term. A large spill in the Strait of Juan de Fuca would almost certainly extend to the shoreline of both the United States and Canada.

TERRESTRIAL VEGETATION

Construction, Operation, and Abandonment

If the pipeline were to cross areas where extensive cutting and filling was required for construction, reclamation would be limited on the steep slopes and vegetation loss would be irreversible. Vegetation removed from the corridor would be an irretrievable loss over the short term.

Oil-Spill Risk Analysis

Chronic small oil spills would cause the irretrievable loss of vegetation for at least one year. Larger spills would cause the loss of vegetation for many years.

TERRESTRIAL WILDLIFE

Construction, Operation, and Abandonment

Construction and operation of the proposed facilities would result in a loss of wildlife habitat for the duration of the project. Present wildlife could relocate to adjacent areas.

Oil Spill Risk Analysis

A major oil spill could result in the loss of individual animals due to oiling, toxicity, and a reduction of habitat. An irretrievable loss of upland wildlife habitat during the period of soil and vegetation recovery would probably not be significant to larger, more mobile wildlife. The loss of less mobile species would not affect regional populations. The most significant loss of wildlife would occur if wetlands were contaminated.

CULTURAL RESOURCES

Construction, Operation, and Abandonment

There are two recorded prehistoric sites at the onshore storage site. Even if salvaged, these sites would be lost from the in-place resource base. Once construction is underway, cultural resources not previously identified at the site or along the pipeline route could be partially or totally destroyed before the resource was recognized and construction stopped.

Oil-Spill Risk Analysis

An oil spill in the vicinity of cultural resource sites could cause damage to the sites directly or indirectly during cleanup operations. This could be a considerable problem in the San Juan Islands where there are numerous sites on the beaches.

VISUAL RESOURCES

Construction, Operation, and Abandonment

The large scar through the bluff at the onshore storage site would irreversibly alter the landscape, causing a permanent visual impact when viewed from the Strait of Juan de Fuca. Similarly, the bluffs traversed crossing Admiralty Inlet and Saratoga Passage would constitute irreversable alterations of the land and would be visual intrusions to persons in the viewing vicinity.

LAND USE, TRANSPORTATION, AND UTILITIES

Construction, Operation, and Abandonment

Construction of the onshore storage facility would cause the loss of almost 300 acres of forest and pasture lands and displacement of three residences. It would also preclude residential development. These losses would probably be permanent because it is expected that other industrial or intensive use would follow abandonment of the storage facility.

The pipeline right-of-way, pump station sites, and powerline rights-of-way represent irreversible land-use commitments for the life of the project. Given the increasing environmental difficulty of routing utilities, it is likely that the pipeline corridor would, when abandoned, be converted to a utility or transportation corridor rather than be permitted to revert to the pre-existing or other unencumbered use. Thus, the corridor would likely remain for the long-term.

Oil-Spill Risk Analysis

Major impacts from oil spills to land use and transportation and utility networks would be expected to be short-term disruptions. Productivity of agricultural lands could, however, be seriously degraded for up to 5 years with reclamation efforts, and indefinitely without.

RECREATION

Construction, Operation, and Abandonment

Construction of the proposed facilities would change the recreational character or nearby areas for the duration of the project. Recreational use of one campground and a day use area would be irretrievably reduced for this period due to the proximity of the facility and changed visual appearance.

Oil-Spill Risk Analysis

Oil spills and resulting cleanup efforts would disrupt recreational activities. In most instances this would cause irretrievable loss of marine-related activities for the period of cleanup and recovery.

A submarine pipeline rupture would cause the irretrievable loss of shoreline and marine activities for the duration of containment and cleanup. Minor irreversible losses of fish and shellfish would occur.

SOCIAL AND ECONOMIC CONDITIONS

Construction, Operation, and Abandonment

The proposed construction and operation of the port and onshore storage facilities would result in major irretrievable and irreversible changes in Clallam County. An oil port would be the first major contributor to the local economy not reliant on locally produced natural resources. To many residents in the area, the project's construction would irretrievably decrease the quality of life.

During construction, operation, or abandonment, loss of life or limb from accidents would be irretrievable.

The system would irreversibly commit approximately 5 miles of 48-inch steel pipe in submarine pipelines. Approximately 25,000 tons of steel used in constructing the port and onshore storage facility would likewise be irreversibly committed. A major portion of this steel could be salvaged upon termination of the project. Nonsalvageable steel and other natural resources would be irretrievably lost, including 5,000 cubic yards of sand, gravel, and cement used in making concrete; an undetermined volume of select fill; 25 tons of copper; and 36,000 board feet of lumber.

Along the pipeline route, construction, operation, and abandonment would result in irretrievable changes in some small communities. For the most part these changes would be short-term during the construction stage. The project would probably result in long-term commitments of existing refineries in market areas to the continuation of their refining operations.

Construction of the United States portion of the pipeline would commit about 50,000 tons of steel including the pipe, storage tanks, and support equipment. The steel in some of these items would be reclaimable upon the termination of the project. In addition, natural resources committed to the construction and conversion of the project would be irretrievably lost, including 3,000 cubic yards of sand, gravel, and cement used in concrete; 5,000 cubic yards of select fill; 9 tons of copper; 7,000 board feet of lumber; and unknown quantities of water and fuel.

Implementation of the project within the United States would irretrievably commit approximately 1,100 workers for various periods of time during the construction phase. Construction would require the equivalent of approximately 885 man-years of labor in direct employment. Once construction was finished, permanent employment of 36 persons would be irretrievably committed to operate the system for the 20-year project life.

Additional unknown numbers of workers could be committed to assess, mitigate, or compensate for project impacts.

The commitment of power during operation would be substantial. Annual electric power requirements for operating the port facility and the three pump stations would amount to 370,490 MWH (megawatt hours).

Oil-Spill Risk Analysis

A major oil spill would result in the irretrievable commitment of human and material resources for cleanup efforts. A spill could cause an irretrievable decrease in the quality of life in the area affected.

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8.5 SUMMARIES OF TITLE V PROPOSALS

Tables 8.5-1, 8.5-2, 8.5-3, and 8.5-4 identify differences and similarities of each of the four proposals submitted under Title V PURPA to construct and operate a crude oil transportation system. The information presented in the tables summarizes the information contained in Chapters 1 through 7 for Northern Tier Pipeline Company, and Chapters 1 and 8 for Northwest Energy Company, Kitimat Pipe Line Ltd, and Trans Mountain Pipe Line Corporation.

Table 8.5-1 describes each of the proposals. Table 8.5-2 describes the conditions which exist along the sea legs, specifically those along the inland waterways. Tables 8.5-3 and 8.5-4 summarize the more significant impacts for each resource.

Executive Order 12114, signed by the President on January 4, 1979 exempts environmental analysis as required by NEPA for actions within a foreign country. Therefore, Tables 8.5-3 and 8.5-4 smmarize impacts which would occur only within the United States. Since the Kitimat Pipe Line Ltd. proposal lies entirely within Canada, impacts were not analyzed in detail.

Impacts associated with each of the four proposals would generally be similar on a mile by mile basis with impacts on any specific resource having similar frequencies, durations, and intensities. The magnitude or extent of impacts would depend on the extent of resources encountered: Cumulative impacts would generally correspond to the size and length of the project with cumulative impacts being greater for larger projects. Impacts on United States resources would occur along the following approximated distances for each proposal:

Northern Tier Pipeline Company	-	1500 miles
Trans Mountain Pipe line Corporation	-	150 miles
Northwest Energy Company	-	15 miles

Most impacts would occur during project construction and would last for a few days to a year or more. Construction impacts include degradation of water quality, degadation of air quality, loss of fish and wildlife habitat, disruption of transportation and utility networks, demands on housing, goods, and community services, changes in land use and visual quality, loss of cultural resources, soil erosion, annoyance and inconvenience to residents and recreationists, loss of vegetation, loss of marine resources, and strains on local government budgets. Most of these impacts would again occur, but to a lesser degree, during project abandonment.

Impacts which would continue for the life of the project include degradation of air quality at the ports from tanker emissions, loss of marine resources from small chronic oil spills, restricted use within the pipeline right-of-way, aggravation of potential power shortages, and increased tax revenues.

The most significant impact which could occur during project operation would result from an oil spill, fire, explosion, or earthquake. These are events which may or may not occur according to their statistical predictions.

A major oil spill of several thousand barrels while in transit would have similar effects for all proposals. Many miles of sparsely developed coastline would likely be contaminated. Both U.S. and Canadian coastlines could be reached, although the likelihood of an oil spill along the inland waterway of the NEC proposal reaching Canadian shoreline is remote. An oil spill in the 200 mile inland waterway leading to Skagway would have the potential to reach more miles of U.S. shoreline than the two proposals in the Strait of Juan de Fuca. Should an oil spill occur in any inland waterway, substantial impacts would occur and last for many years. Sport and commercial fishing time would be lost causing loss of income and fish products. Fishing gear could be fouled and damaged. Tourism and associated incomes would be reduced. Non-reimbursed costs for cleanup of private property would accrue. Marine organisms including anadromous fish would be reduced for many years. Use of commercial and industrial waterfront property could be interrupted.

A fire or explosion at any of the port facilities could cause structural damage to nearby buildings and vessels and loss of life or limb. The potential for these impacts would be greater in Port Angeles harbor because of its greater activity. A fire or explosion could also lead to a major oil spill.

TABLE 8.5-1 DESCRIPTION OF THE PROPOSALS

Major Design Features	NTPC	NEC	KPL	TMC
Sea leg (nautical miles)				
High seas	1,188	535	556	1,188
Inland waters	61	219	250	42
From Valdez Ak, Total	1,249	754	806	1,230
Maximum tanker size (Dead weight tons)	300,000	225,000	320,000	200,000
Tanker port calls/year				
Initially	300	206	84	205
Ultimately	395	Unknown	156	Unknown
Port site	Port Angeles, Washington	Skagway, Alaska	Kitimat, British Columbia, Canada	Low Point, Washington
Port type	Two fixed berths; no dredging	One fixed berth; no dredging	Two floating berths; no dredging	Two single point moorings; no dredging
Submarine pipelines from port to onshore storage facility (number-length-diameter)	2-5.2 miles-48" or 52"	No submarine pipeline 1-3.5 mile-42" underground line	None	2-2.5 miles-48"
Onshore storage facility location-size	6 miles east of Port Angeles-242 acres	1 mile north of Skagway-73 acres	Near Kitimat Size not identified	18 miles west of Port Angeles at Low Point-300 acres
Storage tanks (capacity in barrels)				
Initially	11-6 million	8-4 million	5-3 million	8-4 million
Ultimately	18-10 million	Unknown	9-5 million	Unknown
Pipeline route	Port Angeles, Washington to Clearbrook, Minnesota	Skagway, Alaska to Keg River, Alberta, Canada	Kitimat, British Columbia to Edmonton, Alberta Canada	Low Point Washington to Edmonton, Alberta, Canada
Pipeline mileage				
U.S.	1,491	14	0	148
Canada	0	696	753	675
Total	1,491	710	753	823

TABLE 8.5-1 DESCRIPTION OF THE PROPOSALS (Continued)

Major Design Features	NTPC	NEC	KPL	TMC
States and Provinces crossed	Washington, Idaho, Montana North Dakota, Minnesota	Alaska, British Columbia, Yukon Territory, Alberta	British Columbia, Alberta	Washington, British Columbia, Alberta
Pipeline size (diameter-length)	42 inch-800 miles 40 inch 700 miles	34 inch-627 miles 36 inch-83 miles	36 inch-753 miles	30 inch-823 miles
Submarine pipelines (number-length-diameter)	1-18.3 miles -42 inch 1-4.2 miles -42 inch	None	None	1-3.25 miles-30 inch 1-2.25 miles-30 inch
Pipeline parallel to existing utility corridors (miles)	504	11 (U.S.) 400 (Canada)	Most of route	54 (U.S.) 675 (Canada)
Right-of-way width (feet)				
Construction	90	90	90	75
Permanent	75	45 and 75	60	60
Mainline stations				
Initially	18	1 (U.S.) 7 (Canada)	10	3 (U.S.) (Canadian not identified)
Ultimately	21	Not identified	16	Not identified
Throughput volume (barrels per day)				
Initially	709,000	500,000	450,000	500,000
Ultimately	933,000	750,000	900,000	30,000
Additional potential	350,000	None	None	None
Utilization of existing systems	None	1312 miles in Canada	925 miles in Canada	1,027 miles in Canada

TABLE 8.5-1 DESCRIPTION OF THE PROPOSALS (Continued)

Major Design Features	NTPC	NEC	KPL	TMC
Delivery points in U.S. and volumes in barrels per proposed Initially	Montana: 50,000 95,000 North Dakota: 14,000 Minnesota: 550,000	Delivery points other than Minnesota not identified	Delivery points other than Minnesota not identified	Delivery points other than Minnesota not identified
Ultimately	Montana: 60,000 115,000 North Dakota: 18,000 Minnesota: 740,000	Delivery points other than Minnesota not identified	Delivery points other than Minnesota not identified	Delivery points other than Minnesota not identified
Capability of system to supply additonal points in northern tier states	Yes	No	No	Yes
Construction time	2 years	2 years	2 years	2 years
Construction cost estimates by applicants				
U.S. portion				
Initially	$1.2 billion (1978 U.S.)	$219 million (1978 U.S.)	None	$200 million (1979 U.S.)
Ultimately	$43 million additional	Not identified	None	Not identified
Canadian portion				
Initially	None	$700million (1978 $U.S.)	$750million (1977 Can.)	$383million (1979 Can.)
Ultimately	None	Not identified	Not identified	Not identified
Bunker Fuel % sulfur	0.45	0.2	Unknown	2.0
Annual operating costs for initial throughput				
U.S. portion	$49.6 million (1978 $ U.S.)	$10.1 million (1978 $U.S.)	None	$12.0 million (1979 $U.S.)
Canadian portion	None	$29.3 million (1978 $U.S.)	Not identified	$34.3 million (1979 $Can.)

TABLE 8.5-2 CONDITIONS ALONG SEA LEGS

Sea Leg Conditions	Northern Tier Pipeline Company	Northwest Energy Company	Kitimat Pipe Line Ltd.	Trans Mountain Oil Pipe Line Corporation
HIGH SEAS[1]/				
Valdez to Channel Entrance	1188 Nautical miles (NM)[2]/	535 NM[3]/	556 NM[4]/	1188 NM[2]/
Indonesia to Channel Entrance	6200 NM	6000 NM	6000 NM	6200 NM
Persian Gulf to Channel Entrance	10,650 NM	9200 NM	9200 NM	10,650 NM
INLAND WATERWAY				
Channel Entrance to Port	61 NM[2]/	219 NM[3]/	250 NM[4]/	42 NM[2]/
Shoreline Characteristics	Numerous scattered rocky, sandy beaches	200 mile fjord, few beaches, mostly steep, rocky bluffs	Last 125 miles are fjords, few beaches, mostly steep, rocky bluffs	Numerous scattered rocky, sandy, beaches
Average channel Width	20 miles	5-10 miles except average 1 mile width for last 12 miles	2 miles wide for last 45 miles	20 miles
Navigation Constriction	None	2/3 mile wide channel 15 miles from Port	1 mile wide channels at 5, 18, 57, and 67 miles from Port	None
Emergency Anchorage	Numerous areas within Strait of Juan de Fuca	Few, if any, limited areas for last 200 miles	Few limited areas for last 125 miles	Numerous areas within Strait of Juan de Fuca
Maneuverability Distance	Unrestricted	Restricted for last 200 miles	Restricted for last 125 miles	Unrestricted
Wind Conditions	Infrequently up to 50 mph -astern, ahead, and variable	Frequently up to 55 mph -astern and ahead	Frequently up to 55 mph -astern and ahead	Infrequently up to 50 mph -astern, ahead, and variable

TABLE 8.5-2 CONDITIONS ALONG SEA LEGS (Continued)

Sea Leg Conditions	Northern Tier Pipeline Company	Northwest Energy Company	Kitimat Pipe Line Ltd.	Trans Mountain Oil Pipe Line Corporation
Wave Conditions	Occasional wave conditions which could affect maneuverability	No anticipated wave conditions which would affect maneuverability	No anticipated wave conditions which would affect maneuverability	Occasional wave conditions which could affect maneuverability
Currents	Generally average up to 2 knots	Generally average up to 2 knots	Generally average up to 2 knots	Generally average up to 2 knots
Vessel Traffic	Moderate ship and small craft traffic	Low Ship and small craft traffic	Low Ship and small craft traffic	Moderate ship and small craft traffic
Conflict with Existing Uses	None	Potential interference with commercial fishing	None Identified	None
Threatened and Endangered Species	Gray whale, humpback whale, bald eagle	Humpback whale, possibly gray whale	Unknown	Gray whale, Humpback whale, bald eagle
Effect of Major Oil spill	Could contaminate many miles of U.S. and Canadian shoreline and disrupt and reduce their fisheries	Could contaminate many miles of U.S. shoreline and disrupt and reduce its fisheries	Could contaminate a few miles of U.S. and many miles of Canadian shoreline and disrupt and reduce their fisheries	Could contaminate many miles of U.S. and Canadian shoreline and disrupt and reduce their fisheries
Estimated frequency of oil spill:	709,000 bpd throughput	500,000 bpd throughput	450,000 bpd throughput	500,000 bpd throughput
greater than 2.4 barrels	1 spill every: 3.8 years	1 spill every: 1.4 years	1 spill every: Unknown	1 spill every: 8.3 years
greater than 10,000 barrels	116 years Source: OIW 1978	41 years Source: NEC 1979	Unknown	168 years Source: TMC 1979[5]

[1] Distances approximate and could vary depending on actual route traveled

[2] Channel entrance at Cape Flattery

[3] Channel entrance at Cape Ommany

[4] Channel entrance at Dixon Entrance

[5] The methodology used to determine these risks was different than for the other two applicants; therefore, the risk figures between this and the other two applicants may not be equivalent.

TABLE 8.5-3 SUMMARY OF IMPACTS--PORT AND ONSHORE STORAGE FACILITIES

RESOURCE	NTPC	NEC	TMC
	Port and Onshore Storage Facilities		
Air Quality	Construction		
	On-site increase in pollutant levels should be within standards. Intermittent dust emissions between 0.5 and 2-7 tons per day during an 18 month period could be a nuisance on Green Point.	On-site increase in pollutant levels estimated to be within class II standards.	On-site increase in pollutant levels estimated to be within standards.
	Operation		
	Class I sulfur dioxide standard could be exceeded about 10 days annually at Olympic National Park.	Potential to approach class II maximums for sulfur dioxide about 10 days a year.	Emissions estimated to be approximately the same as for NTPC.
	Abandonment		
	Similar to construction.	Similar to construction.	Similar to construction.
Noise	Construction		
	Annoying noise levels during 18 months in vicinity of Ediz Hook and Green Point.	Moderate, noticeable increase in noise levels related mostly to pile driving and blasting operations.	Moderate, noticeable increase in noise levels.
	Operation		
	Occasional annoying noise levels to residents on Green Point.	Insignificant noise increase.	Insignificant noise increase.
	Abandonment		
	Similar to construction but reduced.	Similar to construction, much reduced.	Similar to construction but reduced.

TABLE 8.5-3 SUMMARY OF IMPACTS--PORT AND ONSHORE STORAGE FACILITIES (Continued)

RESOURCE	NTPC	NEC	TMC
Topography	Construction		
	Alteration of bluff and 140 acres on Green Point and 19 acres on Ediz Hook facility.	Alteration of 116 acres, 62 of which are already used as a storage facility.	Alteration of up to 300 acres including scar on bluff.
	Abandonment		
	Scar on bluff would remain.	No Significant impacts.	Scar on bluff would remain.
Geology	Construction		
	Increased potential for landslides at Green Point.	Increased slide and rockfall potential at port and along 2,500 feet of pipeline to onshore storage facility.	Increased potential for land slide in unstable areas.
Soils	Construction		
	140 acres soil disturbance at Green Point. Low water erosion potential at rate of 1.4 to 3.2 tons per acre per year.	116 acres soil disturbance. Low estimated water erosion loss.	Up to 300 acres soil disturbance. Low estimated water erosion loss.
Aquatic Resources Physical Components	Construction		
	Perched water table removed. Temporary increase in turbidity and sediment in Siebert Creek.	Flows into Skagway River could be altered. Minor sediment increase in Skagway River.	Temporary increase in turbidity in Murdock and Suzie River and Lyre River.
	Operation		
	Minor degradation of water quality in Siebert Creek from effluent discharge.	Minor degradation of water quality in Skagway River from effluent discharge.	No significant Impacts.
Biological Components	Construction		
	No significant impacts.	Minor reduction of salmon and trout populations in Skagway River.	No significant impacts.

TABLE 8.5-3 SUMMARY OF IMPACTS--PORT AND ONSHORE STORAGE FACILITIES (Continued)

RESOURCE	NTPC	NEC	TMC
	Operation		
	No significant impacts.	Minor reduction of salmon and trout populations in Skagway River from effluent discharge.	No significant impact.
Marine Resources	Construction		
	Disturbance of harbor bottom and degradation of marine water quality from laying two-5 mile submarine pipelines.	Minor impacts from berth construction.	Disturbance of bay bottom and degradation of marine water quality from laying two-2.5 mile submarine pipeline.
	Operation		
	Degradation of marine water quality from small chronic oil spills.	Degradation of marine water quality from small chronic oil spills.	Degradation of marine water quality from small chronic oil spills.
Biological Components	Construction		
	Loss of some shellfish in Port Angeles-Green Point-Dungeness Spit area.	Minor impacts from berth construction.	Disturbance to marine mammals and water fowl.
	Operation		
	Loss of shellfish and finfish from small chronic oil spills.	Loss of shellfish and finfish from small chronic oil spills. Ship traffic could interfere with migration of the endangered humpback whale.	Loss of shellfish and finfish from small chronic oil spills.
Terrestrial Vegetation	Construction		
	159 acres of natural vegetation removed from Ediz Hook and Green Point.	Up to 116 acres of vegetation removed including about 10 acres of low grade timber.	Up to 300 acres of natural vegetation removed.

TABLE 8.5-3 SUMMARY OF IMPACTS--PORT AND ONSHORE STORAGE FACILITIES (Continued)

RESOURCE	NTPC	NEC	TMC
	Operation		
	No regrowth of timber for life of project.	No regrowth of timber for life of project.	No regrowth of timber for life of project.
Terrestrial Wildlife	Construction		
	Bald eagle roosting habitat removed on Green Point. Wildlife habitat on 242 acres removed.	None identified.	Removal of up to 300 acres of wildlife habitat.
	Operation		
	Eagles would avoid Green Point feeding, roosting, and nesting areas. Wildlife would avoid vicinity.	No significant impacts.	Precluded wildlife use on 300 acres.
Cultural Resources	Construction		
	Possible destruction of previously unknown fossil deposits and historical and archaeological sites.	Possible destruction of previously unknown fossil deposits and historical and archaeological sites.	Two documented sites at Low Point would be removed.
Land Use	Construction		
	Displacement of 110 acres of log storage pilot station, marina and boat ramp, Vertical Omni Range Station. 242 acre site changed from forest to industrial use.	Change 10 acres of low grade timber forest to industrial site.	Loss of up to 300 acres of pasture and woodland. Three households displaced; 300 acre site changed from pasture, woodland, residential use to industrial use.
Transportation and Utility Networks	Construction		
	190 percent increase in vessel traffic in Port Angeles harbor. Significant increase in vehicle traffic in Port Angeles area.	Increased barge traffic could cause significant traffic problem within the port.	Increased vessel traffic in Strait of Juan de Fuca. Substantial increase in traffic on roads in Port Angeles.

TABLE 8.5-3 SUMMARY OF IMPACTS--PORT AND ONSHORE STORAGE FACILITIES (Continued)

RESOURCE	NTPC	NEC	TMC
	Operation		
	Electric power requirements would significantly aggravate potential power shortage	No significant impacts.	Electric power requirements would aggravate a potential power shortage.
Social Conditions	Construction		
	Temporary strains on housing, sewer and water systems, police and fire protection in Port Angeles and Clallam County.	Large population increase in Skagway. Severe strains on housing, public utilities, and public services especially sewer and water systems.	Temporary strains on housing, police, and fire protection in Port Angeles and Clallam County.
Economic Conditions	Construction		
	Work force in Port Angeles increased by 1,500. Increase in prices of goods, services and rentals. Temporary strain on local government budgets.	Temporary substantial increase in employment. Turnover rate of non-project jobs could be significant. Temporary strain on local government budgets.	Temporary substantial increase in employment and personal income. Temporary strain on local government budgets.
	Operation		
	Increased tax revenue. Substantial increase in personal income.	Substantial increases in tax revenues. Some construction workers remaining could put minor strain on public assistance and family service funds.	Substantial increase in personal income and tax revenues.
	Abandonment		
	Loss of personal income and tax revenue.	Loss of local tax revenue.	Loss of personal income and tax revenue.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS (Continued)

RESOURCE		NTPC	NEC	TMC
		PIPELINE SYSTEM		
Air Quality	Construction	Pollutant emissions would be within standards. Fugitive dust emissions along route.	Unquantified increase in pollutant levels estimated to be within standards.	Unquantified increase in pollutant levels estimated to be within standards.
	Operation	Localized concentrations of hydrocarbons at transfer and delivery facilities in Montana, North Dakota, and Minnesota within standards.	No significant impacts.	Increase in pollutant levels estimated to be within standards.
	Abandonment	Similar to construction but reduced.	Similar to construction but reduced.	Similar to construction but reduced.
Noise	Construction	High noise levels in daytime for about one month could annoy some residents.	High noise levels in daytime for about one month.	High noise levels in daytime for about one month could annoy some residents.
	Operation	Not excessive.	Not excessive.	Not excessive.
	Abandonment	Similar to construction.	Similar to construction.	Similar to construction.
Topography	Construction	Significant alteration of landscape on steep slopes and bluffs.	Alteration of landscape on steep slopes and bluffs. Generally follows railroad corridor.	Significant alteration of landscape on steep slopes and bluffs.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS (Continued)

RESOURCE		NTPC	NEC	TMC
Geology	Construction	8,600 to 1.6 million cubic yards per mile geologic material altered. Landslide, rockslide, and rockfall potential increased by enlargement of cuts in colluvial and bedrock slopes.	Up to 1.2 million. cubic yards per mile of geologic material altered. Landslide, rockslide, and rockfall potential increased by enlargement of cuts in colluvial and bedrock slopes.	4,700 cubic yards per mile of geologic material altered. Rockslide, and rockfall potential increased by enlargement of cuts in colluvial and bedrock slopes.
Soils	Construction	20,000 acres of soil disturbance and temporary loss of soil productivity. Significant soil erosion loss on steep slopes; average soil loss about 50 percent above normal.	135 acres of soil disturbance. Potential for soil erosion could be significant due to shallow soils.	1,400 acres of soil disturbance. Significant soil erosion loss on steep slopes.
	Abandonment	Similar to construction.	Similar to construction.	Similar to construction.
Aquatic Resources Physical Components	Construction	Significant sediment increases in streams below crossings. Decreased base flow in streams from testing.	Temporary sediment increase in streams below four stream crossings not considered significant.	Significant sediment increase in streams below crossings. Decreased base flow in streams from testing.
	Operation	Degradation of water quality and reduced salmon and trout populations in some streams from erosion.	Minor sediment increase could reduce salmon and trout populations.	Degradation of water quality and reduced salmon and trout populations in some streams from erosion.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS

RESOURCE		NTPC	NEC	TMC
Biological Components	Construction	Significant sediment increase and reduced salmon and trout populations below stream crossings.	Minor sediment increase could reduce salmon and trout populations below stream crossings.	Significant sediment increase and reduced salmon and trout populations below stream crossings.
	Operation	Reduced salmon and trout populations below some stream crossings from erosion.	No significant impacts.	Reduced salmon and trout populations below some stream crossings from erosion.
Marine Resources Physical Components	Construction	Disturbance to bottom sediments and degradation of marine quality from laying 22 miles of submarine pipeline across Admiralty Inlet and Saratoga Passage.	No significant impacts.	Disturbance of bottom sediments and degradation of marine water quality from laying 5 miles of submarine pipeline across Admiralty Inlet and Saratoga Passage.
Biological Components	Construction	Loss of some shellfish in Admiralty Inlet and Saratoga Passage	No significant impacts.	Loss of some shellfish in Admiralty Inlet and Saratoga Passage
Terrestrial Vegetation	Construction	Disturbance to 3,900 acres of forestland, 6,600 acres of rangeland, 400 acres of wetland, 300 acres of riparian woodland.	Disturbance to about 135 acres of natural vegetation. Only low grade timber involved. Not considered significant.	Disturbance to 1,585 acres of natural vegetation. Unknown amount of marketable timber removed.
	Operation	No regrowth of timber for life of project.	No regrowth of timber for life of project.	No regrowth of timber for life of project.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS (Continued)

RESOURCE		NTPC	NEC	TMC
Terrestrial Wildlife	Construction	392 acres of wetlands disturbed would reduce waterfowl populations.	Minor habitat losses. No threatened or endangered species involved.	Bald eagle nesting sites disturbed near Point Discovery, Marrowstone, Whidbey and Camano Islands. Peregrine falcon habitat disturbed near Padilla Bay.
Cultural Resources	Construction	Possible destruction of previously unknown fossil deposits and historical and archaeological sites.	Possible destruction of previously unknown fossil deposits and historical and archaeological sites.	Possible destruction of previously unknown fossil deposits and historical and archaeological sites.
	Operation	Increased access for vandals and collectors	Increased access for vandals and collectors	Increased access for vandals and collectors
Visual Resources	Construction	Bluff, scars at Port Williams and Port Partridge.	Excavation and blasting on steep slopes could be highly visible from Carcross Highway.	Breaks in natural continuity of skyline would contrast visually, especially in dense, wooded areas.
Land Use	Construction	20,000 acres affected. One season's production lost on about 6,400 acres cropland/pasture, 6,600 acres rangeland. Trees removed on about 3,900 acres forest/woodland.	135 acres affected, about 1/2 forested. 5 miles of route passes thru Klondike Gold Rush National Historic Park.	1,805 acres affected. Lost production for one season on 680 acres agricultural land. 945 acres of forest taken out of production.
	Operation	Lost tree production on 2,900 acres forest/woodland.	No tree growth in right-of-way.	No tree growth in right-of-way.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS (Continued)

RESOURCE	NTPC	NEC	TMC
		Abandonment	
	One season's production lost on 6,400 acres cropland/pasture, 6,600 acres rangeland.	NEC proposes to leave pipe in place.	Lost production for one season on 680 acres agricultural land.
		Construction	
Transportation and Utility Networks	Traffic congestion and road damage in some areas.	If temporary shutdown of railroad permanent, it would be a significant impact.	Temporary traffic delays on some roads and highways. Significant wear on local roads.
		Operation	
	Electric power requirements would significantly aggravate potential power shortage.	No significant impacts.	Electric power reqirements would significantly aggravate potential power shortage.
		Abandonment	
	Similar to construction	No significant impacts.	Similar to construction
		Construction	
Recreation	Inconvenience to recreationists.	Suspension of railroad use for one tourist season considered an inconvenience.	Inconvenience to recreationists.
		Abandonment	
	Similar to construction.	Minor impacts.	Similar to construction.
		Construction	
Social	Temporary strains on housing, public utilities, police and fire protection in many cities and counties.	No significant impacts.	Temporary strains on housing, public utilities, police and fire protection in many cities and counties.
		Abandonment	
	Similar to construction.	No significant impacts.	Similar to construction.

TABLE 8.5-4 SUMMARY OF IMPACTS--PIPELINE SYSTEMS (Continued)

RESOURCE	NTPC	NEC	TMC
Economic Conditions		Construction	
	Temporary population increase in some communities. Temporary strain on some local government budgets.	No significant impacts.	Temporary population increase in some communities. Temporary strain on some local government budgets.
		Operation	
	Increased tax revenues along route.	Increased tax revenues along route.	Increased tax revenues along route.
		Abandonment	
	Loss of tax revenue.	Loss of tax revenue.	Loss of tax revenue.

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March 3, 1849

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT